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THE DEVELOPMENT OF THE AMERICAN IRON INDUSTRY.

By Edwin C. Eckel.

The statistical features of the American iron industry were discussed in considerable detail in an article presented in this Magazine a year ago, so that at present it will be unnecessary to reconsider this phase of the subject, though the advances in production during 1906 will be briefly noted. Several developments of more general interest can, however, be taken up somewhat more fully. At different times during the year the questions of ore reserves, electric smelting processes, ore-concentrating methods, and corporation mergers have occupied the attention of the iron trade; the statements concerning these various factors in the industry will perhaps be of interest in the present connection as indicating progress along certain lines of development.

THE year 1906 has witnessed a steady growth in production in all branches of the iron industry, from ore to finished products. Coincident with increase in production came increase in prices, which rose steadily from the beginning to the end of the year, with the exception of a slight depression in June. These movements in output and price must be regarded as continuations of the growth shown during 1905, and their relations to the past history of the iron industry can be best noted on comparison of the records of the industry for a number of years preceding.

This recent remarkable growth in the American iron industry is strikingly brought out in Figure 1, which shows graphically the annual production of iron ores, pig iron, and steel for the years 1870 to 1906 inclusive. The figures on which this diagram are based are official, except for 1906. Official statistics for that year are not yet available, but it is believed that the estimates used in preparing the diagram will be found to be very close to the actual figures. The curves bring out clearly the great falling off in production in 1904, and the equally sharp upward movement of 1905 and 1906.

The chief factors in keeping prices down to a reasonable level have been, curiously enough, the great iron- and steel-producing corpora-

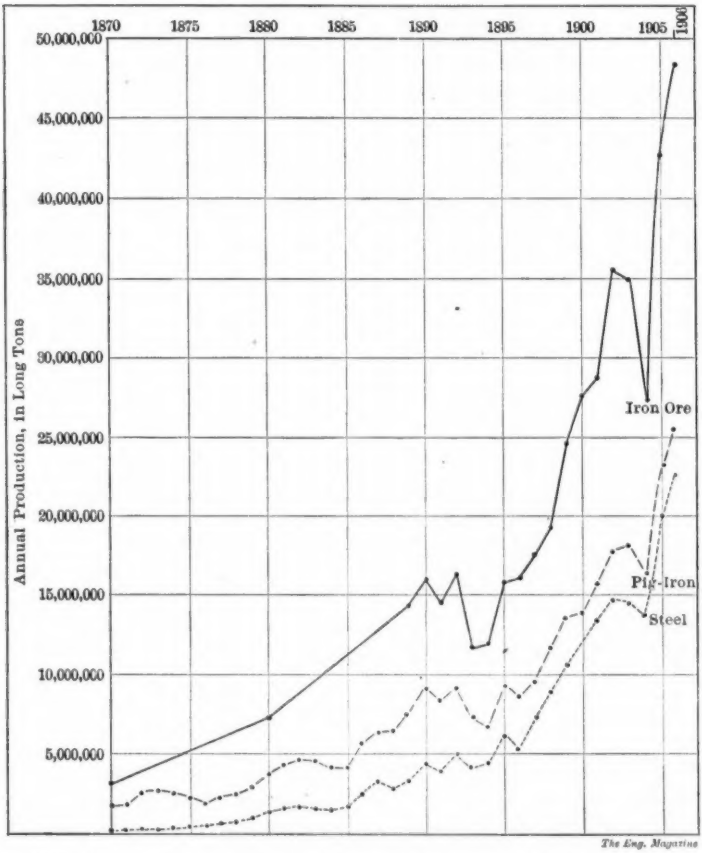


FIGURE 1. CURVE SHOWING THE AMERICAN PRODUCTION OF IRON ORE, PIG, AND STEEL SINCE 1870.

tions. Their attitude in this matter is not, of course, dictated by altruistic motives, but it affords a refreshing contrast to the method of procedure which the newspapers have led us to suppose was the immediate consequence of the consolidation of interests in any industry. Realizing that steady sales at reasonably high profits are, in the end, better than a runaway market with its consequent great fluctuations in both prices and sales, all efforts have been made to steady the iron market so far as is possible; and until within a very recent period this policy was markedly successful. Toward the very close of the

year, however, prices in several lines rose more sharply than is generally considered advisable, and it is doubtful as to how far control will be possible in 1907.

The Share of the Steel Corporation.

In connection with this question it may be noted that at one time in the year considerable public interest was attracted to a discussion between the editor of a leading iron-trade journal and a perennial candidate for the Presidency, regarding the definition of the loosely used terms "trust" and "monopoly." The particular application of the question was to the United States Steel Corporation, and figures collected by Mr. I. M. Swank were presented to show the proportion of various iron and steel products controlled by that company. These figures are given in the table on page 684.

It will be seen from these figures that the Steel Corporation produces somewhat less than half the pig iron of the country, and that its iron ore and coke output are proportionately still less. In steel and in most finished products its percentage is considerably higher, but in no case does it reach 70 per cent of the total American output. It may further be noted that in most lines the corporation has fallen off in percentage of production since the early days of its history, though this tendency will probably be checked within a year or so when its present plans for new construction begin to show effect.

The real strength of the Steel Corporation lies, not in its present control of production, but in the fact that its holdings of iron-ore lands in the Lake Superior district are so complete as to prevent any possibility of competition in that line. These holdings are variously estimated as representing from 75 to 85 per cent of the total iron-ore tonnage of the Lake district, and so long as no other ore districts are taken into consideration it is obvious that the ore supply of the independent interests is not large enough to last for many years. In a later section of this article, data are presented relative to other American ore districts, which seem to show that an ore scarcity in the Lake Superior region need not necessarily be taken as meaning the end of competition.

Southern Iron Conditions.

Prominent among the districts which offer hope for the future, when the better of the Lake ore deposits are exhausted, is that which includes the southeastern States from Virginia to Alabama.

In one respect the past year has been disappointing, when the conditions of the iron industry in the South are considered. So far as can be estimated, 1906 will show no material advance over 1905 so far

TABLE SHOWING IRON AND STEEL PRODUCTS OF THE UNITED STATES, AND THE PROPORTION OF EACH CONTROLLED BY THE UNITED STATES STEEL CORPORATION.

	By U. S. Steel Corporation.	By independent companies.	Total shipments and production.	Percentage U. S. Steel Corp 1905.	1904.	1903.	1902
Shipments of iron ore from the Lake region, gross tons	19,251,872	15,101,584	34,353,456	56.0	53.8	58.8	60.4
Total production of iron ore in 1905, gross tons	18,486,556	24,039,577	42,526,133	43.5	38.0	43.8	45.1
Production of coke in 1905, net tons	12,242,909	19,988,220	32,231,129	37.9	36.6	34.2	37.4
Iron and steel actually produced.—Gross tons.							
Bessemer, basic, foundry, and other kinds of pig iron	9,951,891	12,746,513	22 698,404	43.8	44.3	39.9	44.3
Spiegeleisen, ferromanganese, ferrophosphorus and ferro-bessemer	220,257	73,719	293,976	74.9	70.5	81.0	81.0
Total pig iron, including spiegeleisen, etc	10,172,148	12,820,232	22,992,380	44.2	44.6	40.4	44.7
Bessemer steel ingots and castings	7,379,188	3,562,187	10,941,375	67.4	69.0	72.0	73.9
Open hearth steel ingots and castings	4,616,051	4,355,325	8,971,376	51.4	50.4	51.0	52.4
Total steel ingots and castings	11,995,239	7,917,512	19,912,751	60.2	61.0	63.5	65.7
Bessemer steel rails	1,713,610	1,478,737	3,192,347	53.6	57.2	65.6	65.4
Structural shapes	908,096	752 423	1,660,519	54.6	55.1	60.3	57.9
Plates and sheets, excluding nail plate	2,028,429	1,503,801	3,532,230	57.4	58.0	59.9	59.4
Wire rods	1,265,707	542,981	1,808,688	69.9	71.3	73.1	71.5
Bars, skelp, nail plate, open hearth and iron rails, etc	2,063 113	4,583,118	6,646,231	31.0	28.6	29.8	31.1
Total finished rolled products	7,978,955	8,861,060	16,840,015	47.3	47.8	51.2	50.8
Wire nails, kegs of 100 pounds	7,175,418	3,679,474	10,854,892	66.1	67.0	70.6	64.8

as the productions of either iron ore or pig iron are concerned. The system of mining the red ores of the Birmingham district is not one which permits a rapid increase in output to meet a suddenly enlarged demand; and few Southern companies have ever spent much money in intelligent prospecting or development work. Transportation conditions, too, were unfavorable, the inadequacy of the car supply during the past two years being almost incredible.

During the past decade the wages of common laborers in Alabama have more than doubled; and along with the increase in wages is an increase in the general inefficiency of much of this labor. The principal problems before the Southern iron manufacturer are, in fact, connected with labor supply, and within the past year serious efforts have been made both to divert white emigration into this district and to supply the more pressing immediate needs by introducing Italian and Mexican labor. This latter step, though it may help in present need, is of doubtful wisdom, for it seems calculated to add another race problem to the one with which the South has always struggled.

Certain Southern iron companies have suffered in the past from being managed with a view to making profits in Wall Street, rather than in Birmingham. The same condition has existed in other parts of the United States. It is obvious that a manager trained to keep one eye on the stock will often let the other wander from the stack, and that the industrial economy of the company will be diminished just in the ratio that it is run as a stock-jobbing concern. The past year seems to show a change for the better in this line. Two of the most serious offenders of the past—the Tennessee Coal, Iron, & Railroad Co. and the Republic Iron & Steel Co.—are now under one control and practically under one management, and for the moment at least the policy of this management seems to be to bring the plants up to a very high state of industrial efficiency. As pointed out a year ago, the profits of Southern iron making at present go largely to the railroads, which carry the pig iron to northern markets. This condition will disappear as the steel-making capacity of the South is increased; and one of the most encouraging signs at the present day is the extent to which new steel plants are being planned and constructed.

Iron Ore Reserves.

About two years ago, in response to a request from the Swedish Parliament, an eminent Swedish geologist prepared a report on the iron-ore reserves of the world. The report itself attracted little notice in the United States, even among those directly interested in the iron industry. Early in 1906, however, a summary of the report was for-

warded by the American consul at Paris, and the wide circulation given to consular reports in America resulted in drawing considerable attention to the subject in both the daily and the technical press.

The character of the report, in the form in which it reached the American public, is fairly indicated by the following extracts:

> "It will surprise a great many to learn that we are likely to run short in iron inside of a single century if we keep up the present rate of consumption. As a matter of fact we are more likely to increase the consumption than we are to reduce it. The world has only 10,000,000,000 tons of iron ore available. Of these Germany has twice as many tons as the United States. Russia and France each have 400,000,000 tons more than this country . . . Assuming, therefore, as true the claim of geological science that the extent of workable iron-ore beds is known to within a margin of possible error not exceeding 5 per cent, the Swedish report, which is based upon the most authoritative information, has naturally attracted world-wide attention . . . The present output of ore, and the amount of ore actually consumed by each, is as follows, in tons:

Country.	Workable deposits.	Annual output.	Annual consumption.
United States	1,100,000,000	35,000,000	35,000,000
Great Britain	1,000,000,000	14,000,000	20,000,000
Germany	2,200,000,000	21,000,000	24,000,000
Spain	500,000,000	8,000,000	1,000,000
Russia and Finland	1,500,000,000	4,000,000	6,000,000
France	1,500,000,000	6,000,000	8,000,000
Sweden	1,000,000,000	4,000,000	1,000,000
Austria-Hungary	1,200,000,000	3,000,000	4,000,000
Other countries		5,000,000	1,000,000
Total	10,000,000,000	100,000,000	100,000,000

> While it is probable that the foregoing statement does not take into adequate account the undeveloped ore deposits in Utah and Alabama, its teachings are nevertheless obvious and impressive. Of the world's workable iron-ore deposits, as at present known, the United States possesses only about one-ninth, and at the present rate of consumption the entire supply will be exhausted within the present century."

It must be admitted that an official statement such as this might fairly cause alarm to those unacquainted with the facts of the case, and that the daily press cannot be blamed for taking the matter very seriously. As a matter of fact, however, the figures given cannot be accepted as reliable; and it seems desirable to present a more careful statement of the case. The original Swedish report did not do justice to the American iron-ore deposits; while in the consular translation this injustice was accentuated, rather than lessened.

Before taking up the subject of American iron-ore reserves in general it may be well to dispose of one statement above quoted:— "Assuming, therefore, as true *the claim of geological science that the extent of workable iron-ore beds is known to within a margin of possible error not exceeding 5 per cent* . . ." To me this assumption appears to be entirely gratuitous. No mining geologist of any ex-

perience would make such a claim, except for very small or unusually uniform ore-bodies. Elsewhere, in discussing the Clinton or red ores of Alabama, I have said: "The amount of Clinton ore in any area can probably be determined by a geologist within 5 or 10 per cent; and estimates of red-ore reserves can therefore be made by competent men with a degree of accuracy impossible in dealing with the magnetites, hematites, or brown ores of other districts." The Clinton ore, it must be remembered, is an exceptionally easy ore to estimate, because it occurs in bedded form and is fairly uniform over considerable distances, both vertically and horizontally. In dealing with irregularly shaped ore-bodies, I should consider that an estimate which came within 25 per cent of the actual quantity was remarkably accurate. When, however, the estimate covers, not a single area or deposit, but the total iron-ore contained in a State or nation, the case is very different, for the possibility of error in such an estimate is enormous. As will be shown below, the Swedish report on iron-ore reserves probably contains an error of something over 1,000 per cent in its estimate of American ore tonnage.

The Lake Superior district, at present the leading American producer, has been explored more thoroughly than any other ore field in the United States, but estimates as to total tonnage range within rather wide limits. At present the totals commonly quoted vary from 1,500,000,000 to 2,000,000,000 tons, of which the United States Steel Corporation is commonly supposed to control over three-fourths. This supply is being drawn on to meet a constantly increasing annual demand, and it is conceded that before 1915 the district will probably be called upon to ship over 50,000,000 tons of ore a year. It is obvious that at such a rate the Lake Superior ores can hardly be expected to last beyond the year 1950; and it is equally obvious that long before that date the value of good workable deposits of iron ore, both there and elsewhere in the United States, will have increased immensely. During the past year ore lands in the Lake district have been sold at a valuation of one dollar per ton of ore in the ground, though the average valuation is still of course considerably below that price.

In the Rocky Mountain and Pacific states a few large iron-ore deposits are known to exist, and many others are reported, but any attempt at an estimate of total tonnage would be, with only our present knowledge of the subject, merely the wildest sort of guessing.

A more promising field lies in the older Eastern States. It is probable that careful exploratory work will develop magnetic iron ores in New York, New Jersey, and Pennsylvania in quantities far in ex-

cess of anything usually considered possible in those States. Here also, close estimates are impossible.

With regard to the Southern iron ores the case is very different. Here the work which the Geological Survey has carried on during the past three years, and which was planned so as to obtain data on the quantity of ore available, gives us a fairly secure basis for tonnage estimates. I feel safe, therefore, in submitting the following figures as representing *minimum* values for the workable iron-ore reserves of certain Southern States, with the caution that further exploratory work in the South will probably increase rather than decrease these estimates.

	Red ore, tons.	Brown ore, tons.
Alabama	1,000,000,000	75,000,000
Georgia	200,000,000	125,000,000
Tennessee	600,000,000	225,000,000
Virginia	50,000,000	300,000,000
	2,300,000,000	725,000,000

This gives a total estimated reserve, for the red and brown ores of the four States noted, of over 3,000,000,000 tons. If to this we add the ores occurring at deeper levels in the States named, the red and brown ores of Maryland, West Virginia and Kentucky, and the magnetic ores of the other Southern States, it is probably fair to assume that the total American ore reserve will amount to very nearly 10,000,000,000 tons—or five times that credited to the Lake Superior district. Much of this is of course unworkable at the present day, but all of it should be counted on in any estimate of total ore reserves.

In considering the above figures it will be well to bear in mind that the red ores will average 33 to 43 per cent metallic iron, but that they carry so much lime as to be almost or quite self-fluxing. The brown ores, as washed, will range from 40 to 50 per cent metallic iron. It may be further added that the estimates as to red-ore tonnage are probably much more accurate than those relative to brown ores.

To sum up the matter—in place of the eleven hundred million tons credited by the Swedish geologists, it is probably safe to say that the United States has from ten to twenty times that reserve of iron ore.

The present rate of consumption is as follows:

1903	35,019,308 tons
1904	27,644,330 tons
1905	42,526,133 tons
1906	probably about 48,000,000 tons

Assuming that the demand for iron ore during the present century may range from 50,000,000 to 100,000,000 tons per year, the Lake Superior district would last for from 25 to 50 years more, if it supplied

the entire United States. But counting on the known reserves elsewhere in the United States, the ore will last for a much longer period, though of course it must necessarily show a gradual but steady increase in value.

Recent Technologic Advances.

Of processes affecting ore-treatment, the three which have received most attention during the past year or so are probably the Gayley dry-blast, electric smelting, and nodulizing. The first of these is in successful operation at a number of furnaces, and is now hardly subject to discussion as a new or untried process. With the other two the case is different, and some space may profitably be devoted to a brief discussion of this probable status in the iron industry.

There is of course nothing particularly novel in the idea of producing iron or steel in the electric furnace, though some recent experiments appear to ignore this fact and to consider the mere electrolytic production of metal to be the mark of success. The real point is to produce metal in the electric furnace cheaper than in the blast furnace, and concerning this possibility, a great deal of discussion has taken place,—often in a purely academic fashion without much experimental basis. During the past two years, however, a number of experimental plants have been operated in various parts of America and Europe, and our knowledge of the problem is fast assuming a definite shape. Recent exhaustive discussion of the subject by Haanel, Harbord, Kershaw and others seem to warrant the following conclusions:—

1.—Under the conditions which obtain in most of the settled portions of the world, neither pig iron nor ordinary structural steels can be produced in the electric furnace at a cost to compete with the blast furnace.

2.—Under exceptional conditions, where ample water power can be very cheaply developed in the immediate vicinity of the ores, while fuel is very dear, pig iron and steel can be produced profitably in the electric furnace. Harbord estimates that with electrical energy costing $10 per electrical horse power year, and with coke at $7 per ton, the two methods are about on an equality.

3.—Electric smelting may be practicable in the case of titaniferous ores, or other ores difficult to treat in the blast furnace, if the resulting product possesses any properties which would counterbalance the increased cost.

4.—Electric smelting methods can be profitably applied to the manufacture of crucible steel, or other high-grade special steels and ferro-alloys.

It will be seen, therefore, that there is little prospect that electric smelting will have much influence on the general development of the iron and steel industries until fuel supplies become much scantier than they are at present. Considerably more practical results to the industry can be expected from the process next to be considered, though bearing on an entirely different phase of the iron-manufacturers' problems.

In all furnaces, and particularly those running on soft or fine ores, a very appreciable quantity of iron ore is carried out by the blast. This ore-dust, which may amount to 5 per cent or more of the furnace charge (equivalent to 25 to 50 tons per day per furnace) is usually trapped before entering the stoves, so that it can be removed and stored. Its fineness, however, precludes its direct use in the furnace, and hitherto the only method of utilizing it involved the preparation of briquettes. The "nodulizing" process does away with certain difficulties inherent in any regular briquetting process, and seems likely to come into general use as a means for economically handling flue dust. It is of service, also, in other fields, for it can handle the finer material produced during magnetic concentration; and it renders available certain sulphurous products (blue billy, sulphury ores, etc.) which have hitherto been treated with difficulty.

The principal novel point in connection with this process is that it employs rotary furnaces, closely similar to the rotary kilns now so familiar in the Portland-cement industry. These kilns are set slightly inclined, the fine ore is fed in at the upper end, and travels toward the lower end as the kiln revolves slowly. Fuel is sprayed in at the lower end, so that a high temperature is produced there. So far the process is exactly similar to that employed in cement practice. The point of difference lies in the fact that a hydrocarbon or other binder is dropped or sprayed into the ore as it is fed into the upper end of the kiln. As the materials slowly pass downward, the binder mats the ore into little masses or nodules. Further down in the kiln the greater heat causes the tar to combine with the sulphur, if the latter be present, and the two are largely volatilized. Still closer to the discharge end practically all of the binder has disappeared, but the ore-nodules, now free from sulphur, still cohere owing to incipient fusion of their particles, for the heat here approximates to 2,000° F.

It will be seen that this "nodulizing" accomplishes both the consolidation and the desulphurizing of the material; and that its chief advantage, as compared with the older briquetting and roasting processes, arises from the fact that the rotary kiln is an extremely effective labor-saving device.

MECHANICAL AGENCIES IN THE DEVELOPMENT OF CHINESE EXPORT TRADE.

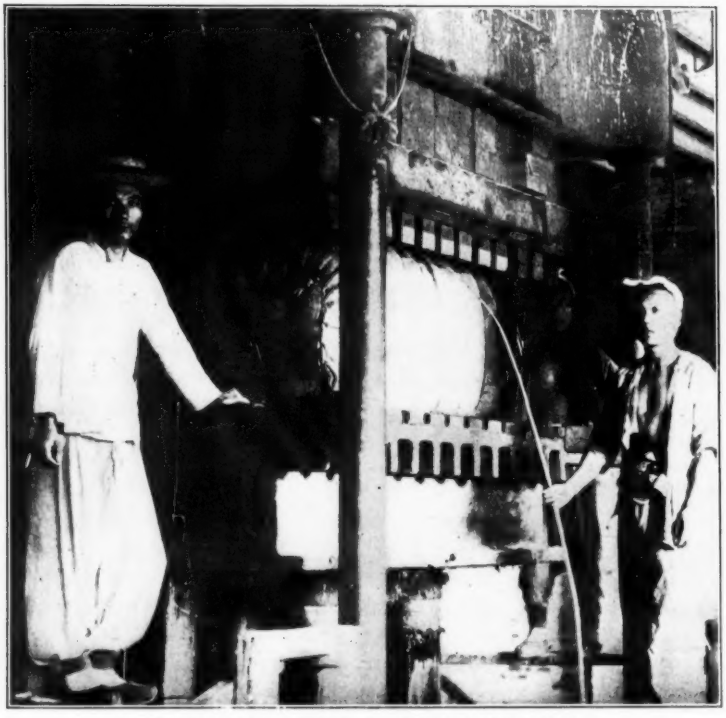
By Barrett Smith.

Mr. Smith's article has two aspects of special interest—one, its exhibition of the commanding part which mechanical skill has played in what might seem a purely commercial field; the other, the side light it throws on the degree of efficiency to be expected from coolie labor when closely associated with engineering operations.—THE EDITORS.

IN the earlier days, the halcyon days of the China export trade for those few then in the game, profits were so large all around that despite the extraordinary freight charges no decided effort was made to lessen the drain on revenue. In the early eighties, however, keener competition began to manifest itself and relief from the freight incubus became imperative. The solution was found in an application of mechanical appliances and processes—ingenious and interesting in itself, and leading immediately to the founding of one of the most important of the industrial enterprises handled by foreigners in China.

This is the hydraulic-press packing of raw produce for shipment to American and European markets. It has been fostered and developed by the unique conditions to such an extent that there are now large plants in many of the treaty ports, notably Shanghai and Tientsin, devoted solely to its pursuit. Practically every non-perishable item in the list of exports is subjected to the process, but the great staples are sheep's wool, camel's wool, cotton, silk, jute, hides and skins, both tanned and untanned, goat rugs, sheep rugs, etc. The centers are Shanghai and Tientsin.

The peculiar conditions of shipment have been referred to already. The characteristic of vital import to the development of hydraulic-press packing in China is the foundation of freight rates on the volumetric ton—45 shillings for 40 cubic feet from the China coast to England and the Continent. In studying the history of any industrial enterprise in its pristine stages we often have occasion to wonder at the difficulty at one time experienced in laying hold of opportunity fraught with technical considerations: so here. In this case the natural supposition seems to be that there had not been one man in China with the eye for the opportunity and the means to advance it until the question was taken up by Mr. Wm. H. Poate, of Mackenzie & Co., general export merchants of Shanghai. In this



OLD-FASHIONED SIMPLE SKIN PRESS AND CREW.
The man on the left is a typical Northern Chinaman.

establishment, as in many other houses in Shanghai, the class of goods described above had been baled for shipping by means of small, low-power hydraulic presses operated by gangs of coolies at the pump brakes. This baling was principally for convenience of handling the cargo and it is obvious, from the examination of this old machinery some of which still remains in scrap on the premises, that the maximum working pressure could not well have exceeded 800 pounds per square inch, while the process must have been tedious beyond endurance. However, it was cheap; and its cheapness was its salvation in the face of such pulsations of modern progress as were felt in China up to that late day when Mr. Poate's operations relegated it to the scrap heap. He was able to convince his colleagues of the good business in his larger proposition. He showed that the saving in freight by packing to great density would far outweigh all the expense con-

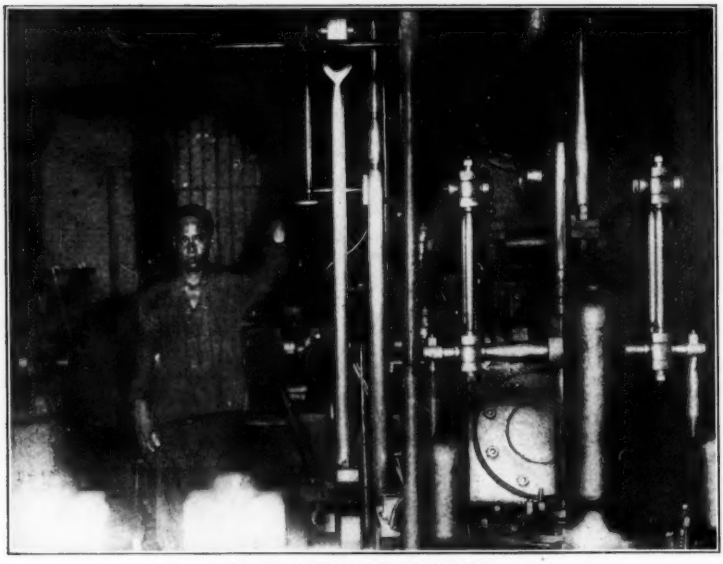
nected with a steam-driven plant capable of the work. It is interesting to note that the promoter derived the possible density of packing at great pressures from curves between pressure and density for various cargos plotted on the little hand presses. It does not appear in the original draft that the function of public press packers for the general trade was contemplated, but it was entered upon in the early days and is now the most important function of the company.

Early in the nineties other companies entered the field, so in the last decade competition has introduced much engineering and managerial refinement in the administration of the larger packing establishments. By agreement there is a uniform rate of charge for public packing, so the lion's share goes to the people guaranteeing the best measurement. Thereafter the problem is the old one of reducing operating expenses, and owing to the lack of first-class engineering talent in the field there is still much room for improvement.

Generally it is a matter of wonderment to the uninitiated that produce may be subjected without injury to this titanic squeeze, amounting often to 6,000 pounds per square inch on the pressure face of a bale. Apparently the danger point has never yet been approached with such cargo as wool, cotton, rugs, etc., though poor stacking has been known to prove ruinous to silk and jute and untanned skins. When properly stacked these, too, may be squeezed to the limit without fear. Certainly the present tendency to increased pressure will lead in time to the danger point, but that point is certainly not within the capacity of any of the presses now in the field, powerful though they are.

The steam end of a typical hydraulic press-packing plant contains little that is characteristic, so it may be passed over with a brief general description. The Lancashire is the popular type of boiler, and the installation is generally very simple, few of the economical boiler auxiliaries, excepting economizers and feed-water heaters, having been attempted as yet. Artificial draft in any form is unknown and mechanical stokers have gained no hold because the Chinaman, properly trained, is about the ideal of the human variety, his wages moreover hardly equalling the upkeep of the equivalent mechanism. While some of the large plants still make shift without them, economizers are gaining a strong foothold, and feed-water heaters have generally accompanied the original equipment.

The typical engine is a slide-valve compound with independent cut-off, in the older installations belt-connected to the pumps, in the later ones direct-connected. In the early days water was so scarce that engines were run non-condensing with exhaust to feed heater.



AN ENGINEMAN AT TIENTSIN.

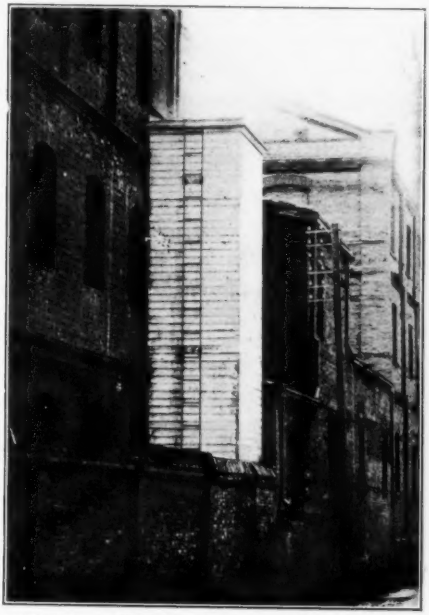
A native of the Shanghai district, imported for the work.

Nevertheless the adoption of compound engines began some time ago when there was prospect of an early amelioration of the stringency of the water supply. This condition applies particularly to Tientsin which is distinctly arid for a large part of the year. In Tientsin the scheme of water supply, upon the consummation of which so much dependence was placed in the general installation of compounds, fell through; so the leading managers have resorted to the continuous use of condensing water, with very satisfactory results. So far the cooling tower has monopolized the field and will likely continue to hold its position because of the prevalence of a dusty atmosphere with severe dust storms occasionally during a part of the year. In Tientsin the usual water source for plant purposes is private artesian wells, in most cases remarkably soft.

The pumps are typical heavy-pressure, horizontal short-stroke sets, crank-driven and arranged in pairs opposed on the same crank. The sets for the larger presses comprise 12 plungers ranging from 2 to 4 inches diameter with an 8-inch stroke. Excepting the smallest size, the plungers are provided with automatic "cut-outs" so adjusted as to maintain a fairly uniform engine load from the time the bale is started, a mass of loose cargo, till it reaches the finished stage and

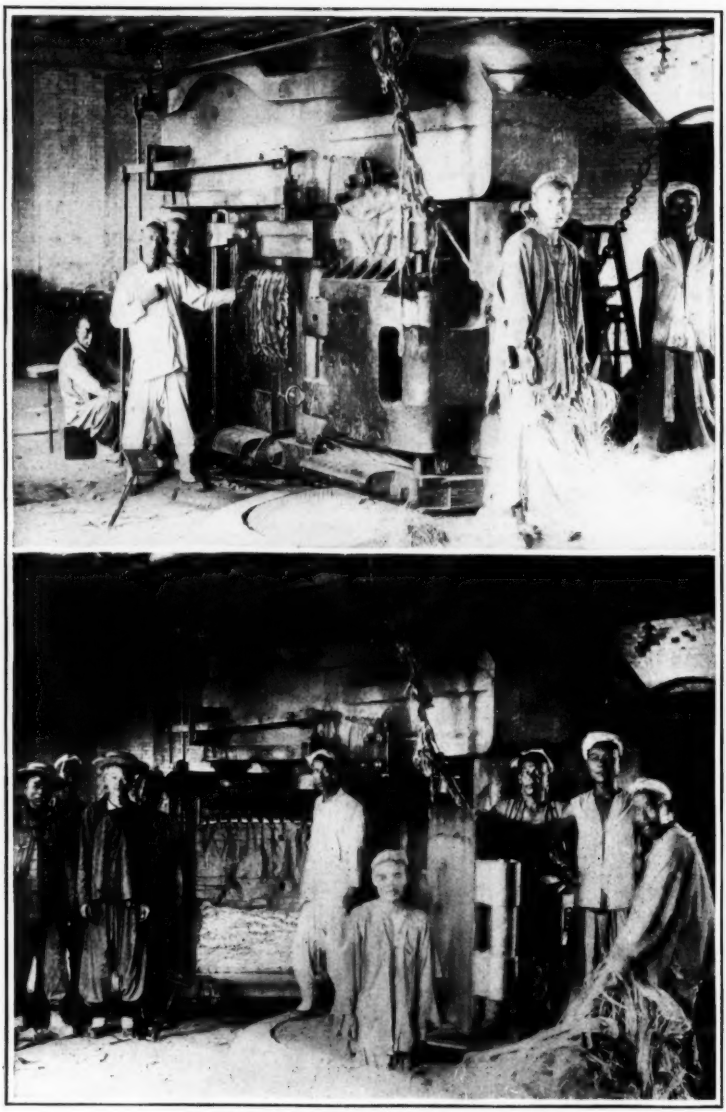
the by pass to the accumulator is opened. The more modern of the pump sets are designed for a working pressure of 60 long hundredweight, or nearly 6,800 pounds per square inch on the finishing plungers, and that pressure is frequently used in practice. The pump valves are the ordinary clack variety.

It is in the presses themselves, however, that lies the deepest interest, for they are the unique feature, the cardinal characteristic feature of the industry under discussion. There are two leading types, the superiority in speed lying with the one, that of power with the other. The hostility of the respective manufacturers so far has frustrated all attempts at amalgamation of type. Each is protected by patents and a sort of deadlock is the result. The buyer pays his money and makes his choice according to his lights. The demand for speed during the "rush" seasons is only a degree less urgent than the demand for power. Moreover the difference in speed is greater than the difference in power. There is little difference in operating expense, but a much heavier first cost has seriously handicapped the speedier press and it is losing ground although some of the most experienced packers believe it to be the better investment. At present the field is about evenly divided.



THE FIRST COOLING TOWER IN NORTH CHINA.
Built by the writer in 1895.

The more rapid of the types is known as the cyclone baling press, and the basic design was conceived by Mr. Poate about fifteen years ago. The press then constructed is a splendid example of British stability of construction and workmanship, never once having been shut down for repairs. A description of this press will serve for the type. The baling is performed in two stages, which aspect gives rise to the nomenclature "prepar-



THE CREW OF A CYCLONE PRESS AT WORK.

In the upper view the press is shown from the preparing side, with preparing doors closed ready for the preparing-ram stroke. The finishing ram is in operation, and in the foreground coolies are filling boxes with jute. In the lower view the finishing revolver is shown half-turned

ing side" and "finishing side," though the press, properly speaking, is a mechanical unit. There are three massive cast-iron heads, horizontal, and three vertical tie bolts of mild steel, the latter ranged in a row along the horizontal center line of the structure and equally spaced to about six feet. The center one of these three bolts, while common to both preparing and finishing sides, really separates them in as far as they may be said to be separated. The two lower heads, located upon different levels, are apportioned to the preparing and finishing sides respectively, while the top head, though a single casting, serves on one side of the center bolt for the preparing and on the other for the finishing function, being more than 14 feet overall. The lower head of the preparing side being located at the ground level, the lower head of the finishing side is carried on a masonry pedestal some twenty feet in the air. The heads bear inside on shoulders forged on the bolts while the tension is entirely taken up by the immense nuts on the outside faces. The inboard end of the lower finishing head is fixed by a nut and collar near the middle of the center tie bolt which continues thence in reduced section to the inboard end of the lower preparing head.

The preparing side is equipped with a cast-iron ram, 11 inches in diameter by 28-feet stroke, designed for the rapid compression of the loose cargo to workable dimensions. With light clean wools a reduction by the ratio of 7 or 8 to 1 is accomplished in this stage. The finishing ram, of cast-iron, gun-metal sheathed, is short and thick, 35 inches diameter with a 20-inch stroke. The rams are located midway between the tie bolts on either side of the center, and thrust upward. The cylinder of the preparing ram is a separate steel casting set through the lower preparing head, but the cylinder of the finisher is cast right in the lower finishing head.

The transfer of the partially packed bale from the preparing to the finishing side is accomplished rotatively through the agency of a bi-symmetric "revolver" turning upon ball bearings around the center bolt immediately beneath the upper head of the press. The material is forced up by the preparing ram and locked in the revolver, the revolver is rotated through 180 degrees, bringing the bale into alignment with the finishing ram, and the finishing ram completes the compression with a 2,500-ton squeeze. In coincidence with this step the other end of the revolver is receiving a new load from the preparing ram, the previous bale in a finished state having been discharged from that end before rotation.

The bale receives its formation initially from the box in which the loose cargo is stacked—a vertical sheet-steel box the length of the

CYCLONE PRESS FROM THE FINISHING SIDE.

The operator is running on the hoop, the bale being under a pressure of 3,000 tons. The preparing doors are open.

preparing ram, through which the ram travels. Combined with the revolver already described this preparing box entirely occupies the height between the preparing heads of the press, the revolver itself serving really as a continuation of the box proper. While the preparing-box structure is fixedly proportioned to the nature of the cargo in hand, the outer end and the sides of the revolver box are formed by massive doors which are released and opened after compression is completed, leaving the bale quite free for running on the hoop. Now there are three of these tall preparing boxes, arranged radially in a structure known as the "preparing revolver," with the outboard tie bolt on the preparing side serving for an axis. While compression is being effected in one box the others are being filled, so the continuous operation of the ram is broken in the minimum degree. The ram, having completed a working stroke, descends;

whereupon the preparing revolver is turned through 120 degrees and the next working stroke is begun. Ideally the only interruption in the steady movement of the rams up and down is the time consumed in swinging the revolvers. There is of course an independable element in Chinese coolie labor, but a good gang of old hands will turn out 40 bales, averaging 650 pounds, in every hour of the working day. A rough estimate of the total weight of this cyclone press is 95 tons.

One of the most interesting features of press packing is the hooping of the bale and the method of hoop retention. A single 90-foot piece is used, run on spirally with 12 complete turns, and grooves in the lash plates provide the means of placing it. At the ends it is simply lapped under and held by the enormous pressure of the overlying spiral. The hoop material is a very fine grade of ductile, low-carbon steel with a guaranteed tensile strength of 90,000 pounds per square inch. The expense of the hoop outweighs all the rest of the operating charges combined. Each bale requires from 10 to 15 pounds, the gauge varying between 14 and 20 according to the cargo. Of all the goods handled the most refractory is clean camel's wool which sometimes elongates the hoop one inch in twelve.

Opposed to the cyclone press there is the rather more powerful and radically different type called for its makers the " G. & B." press. It is of much simpler appearance than the cyclone, all the rams being sunk in a pit and only the finishing revolver showing above the floor. The revolver is not bi-symmetric, but is a single unbalanced box comparable to one-half of the cyclone finishing revolver, and it rotates about a massive pivotal column occupying the center of a circle of four rams. There are three preparing rams and a finisher, 3 inches, 6 inches, 10 inches and 30 inches in diameter respectively. The preparing rams have a uniform stroke of 15 feet and operate each in a separate box fixed in the floor, but the finisher is a short-stroke ram quite comparable to that of the cyclone. All three preparing boxes having been filled with cargo, the contents, beginning with the load on the smallest ram, are progressively rammed up into the revolver box which is rotated into alignment with each ram in turn. A pair of grids sliding across the bottom of this box retains the contents during the changes of position.

In the preparing stage with the G. & B. press a column of cargo 45 feet high is reduced to 5 feet, an advantage over the cyclone preparing reduction, which is 28 to 3.5. Now the horizontal section of the G. & B. baling box is normally much smaller than that of the cyclone box, so the pressure per unit of pressing area, on a similar hydraulic head, is greater, despite the smaller finishing ram. Thus

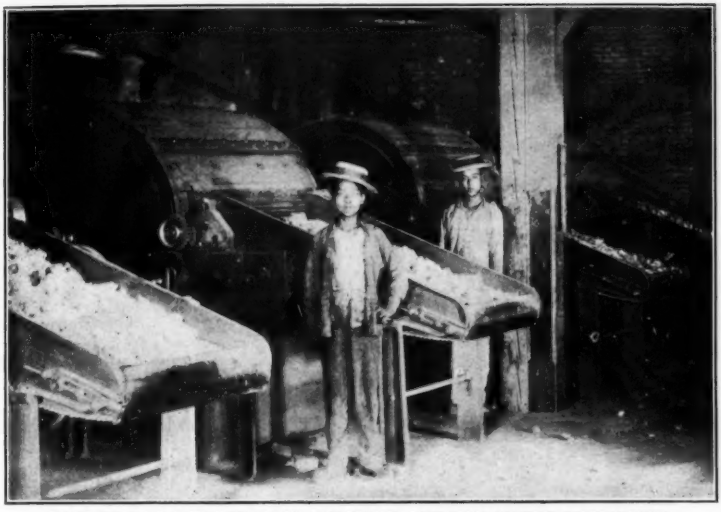
the difference in power is accounted for. Up to the present time, however, the owners of G. & B. presses have not reaped much benefit from their advantage, because of superior engineering skill in Mackenzie & Company's plant, enabling them more nearly to realize the pressure capacity of their pumps in every-day practice.

Probably the Mackenzie pressure standard is 30 per cent above the nearest competitor. It must be understood that working machinery up to its designed standard in China is a difficult matter because of the tendency to irresponsibility among the Chinese rank and file of the engine-room corps.

The comparative slowness of the G. & B. press is very plainly inherent in its design. Only one ram may act at once. The possible maximum of output is 25 bales of 550 pounds each in the hour, so it takes two G. & B. presses to equal the output of one cyclone, and the cost of the G. & B. is rather more than half that of a cyclone. Undoubtedly the question of superiority is a very open one, and the ideal solution from the packers' point of view would be an amalgamation of type embodying the virtues of the two.

Some figures indicating the standard packing densities for various cargos may prove of interest now with the character of the presses in view. The best packing cargo is greasy sheep's wool, which frequently runs 22 piculs to the ton or 73 pounds to the cubic foot. With sheep's wool the density decreases from this maximum with increase of cleanliness, dryness, and fineness, down to lamb's wool which runs only 46 pounds to the foot. Camel's wool varies from 55 pounds with the coarse Peking variety to 40 pounds with the fine grades. The extreme resilience of dry wools greatly impairs density through stretching of the hoop. Could the full capacity of the presses be realized the density would be increased 10 to 15 per cent. Cotton on the other hand is " dead " and stretches the hoop very little, which is also true of jute. Both these cargos will run about 55 pounds on the average and the variation is small. Jute, by the way, often causes considerable injury to the presses by gouging the steel sides of the boxes. It is hardly conceivable that this phenomenon can obtain without injury to the jute itself, but such is really the case. Of the other cargos handled, sheep and goat-skin rugs run about 40 pounds, and untanned skins foot the list of common cargos at 36 pounds, largely because of the irregularity of shape and thickness. An exceptional cargo is deer rugs, which, because of the thick fluffy hair, can be compressed only to about 23 pounds to the foot.

The recollection occurs to me of an incident that illustrates in a graphic and amusing way the difficulty experienced by the unlearned



PART OF A BATTERY OF WOOL CLEANERS, AND TWO OF THE OPERATIVES.

observer in comprehending a phenomenon which was the result of this heavy packing. We were aboard a China coast steamer lying at anchor outside the Taku Bar at the mouth of the Haiho River, taking on cargo from a lighter. This cargo was baled sheep's wool, and through the carelessness of the coolies a bale slipped from the skid and tumbled overboard. It sank like a plummet. "Why," said a lady leaning over the rail nearby, "You said those had wool in them," and her escort was at some pains to clear himself.

Inquiry very naturally arises as to the adaptability of the American steam cotton-press type to the Chinese field, but it will not do. Of course, the speed of the cyclone press, even, is miserable in comparison, but the prime demand out there is density and the best effort of the steam press is puny beside the mighty crunch of the hydraulic ram. Investigation has shown that density under the steam press rarely exceeds 40 pounds to the cubic foot, whereas the average for the hydraulic press on the same class of cotton is 60 pounds. Moreover, the cotton comes to press in the Southern States already quite compactly baled, four or five "country bales" being stacked under the platen and reduced to one. In China, on the other hand, cotton and wool come to press in native bags, loose, and the total volume reduction required is between 10 and 12 to one, which would be impossible for any steam press thus far designed.

But one cardinal feature of purely technical interest now remains untouched in the present discussion, and that is the arrangement of the hydraulic circuits. In the most modern plants, engines, pumps, accumulators and presses are installed on what is known as the "differential group system." The essential point in this system is the design of the power circuits whereby any engine and pump unit in the plant may be coupled to any press with an accumulator selected from any one of the battery, according to the pressure demand of the case. The extreme flexibility of the system will be readily apparent. It permits the exact regulation of the machinery to the characteristics of the goods to be packed, and at the same time a source of relief is afforded in case of breakdown in any quarter.

Our conclusion may be devoted fittingly to a brief discussion of the purely business aspect of the industry of press packing in China, showing how it has rewarded the organizers and proven the acumen of its founder. For the purposes of the present narrative it will suffice if we confine ourselves to the bearing of packing on the Mackenzie business alone. It will be necessary to make assumptions here and there, but with no danger of any wide discrepancy.

In the year 1903, the latest for which we have statistics, this house packed a total of 30,000,000 pounds of cargo of all descriptions, and the average density was 14.4 piculs to the ton, or about 50 pounds to the cubic foot. That is 600,000 cubic feet, of which fully 500,000 feet came to the occidental markets. The freight on this volume at about 45 shillings per ton of 40 cubic feet amounted to nearly $140,000. In the last year of the era of the old hand presses the average density of all cargo packed was less than 4 piculs per ton, in round figures 16 pounds to the foot. At that standard, the freight on the 1903 shipment would have been more than $500,000. The gross saving then is about $360,000.

Now we may foot up the debit items. The plant investment is $600,000, and a liberal interest rate is 9 per cent, so we have $54,000 interest against us. The operating expense was 45 candareens per picul, or say $0.24 per 100 pounds. For 25,000,000 pounds this amounts to $60,000. The total debit is $114,000, and the net saving through packing is $246,000 on the produce handled by this one company.

It is not to be understood that this $246,000 is profit; not by any means, because press packing alone makes possible the general export trade of China, and but for its help there would be a deficit all along the line at the present standard freight rates.

THE RAILWAY YARD AT CRISTOBAL.

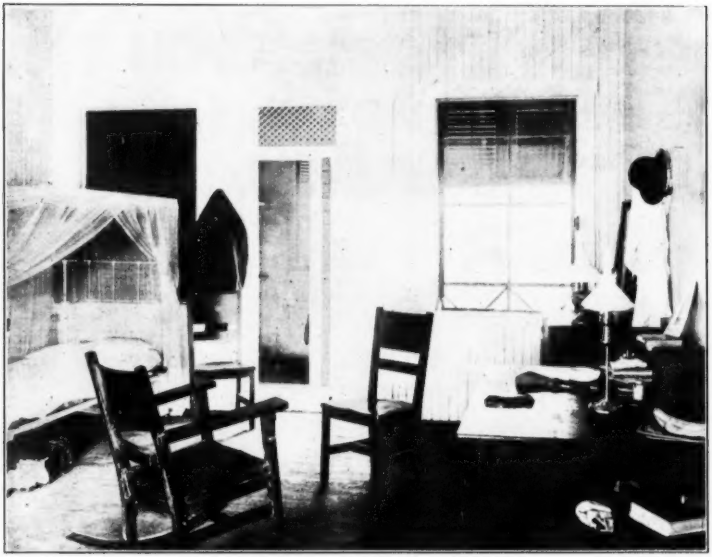
THE PANAMA CANAL WORK, AND THE WORKERS.

A PERSONAL STUDY OF ACTUAL CONDITIONS.

By Fullerton L. Waldo.

Mr. Waldo visited the Isthmus as a private traveler, with observant eyes and trained understanding; he had intimate knowledge of the Canal problems, but no motive except interest in the work and no predisposition to find any given set of facts. His frank, straightforward account just fresh from the Zone and full of the human interest in the situation, is well worth reading Its note of confidence and even enthusiasm is one of the best tributes to the soundness of affairs at Panama, for it is caught from the men in the field—and testimony of that kind can not be pre-arranged. It is inevitably and convincingly genuine.—THE EDITORS.

DURING the Christmas recess of 1906-7, a party of eleven members of Congress was organized to visit the Isthmus and inform themselves regarding the most conspicuous engineering undertaking of modern times. While my trip was undertaken individually and independently, it was my unforeseen good fortune to take the same steamer, and my privilege to be invited to join this party. We crossed the Isthmus four times on a special train, which was stopped at various points to allow of as thorough an investigation of the engineering problems as the limited time at our disposal would permit. With the exception of the chief engineer, who returned to the Isthmus the day after we left, we met almost every one



IN BACHELOR QUARTERS, CULEBRA.

of the higher officials of the Panama Railroad and of the engineer corps of the Canal Commission, and the fullest information was placed before the party by the men best qualified to answer questions.

The more we saw of these men, the more our admiration for them and for their work increased. The time has now come when the self-respecting engineer of high proficiency and technical attainment can afford to go to Panama. It was not always so. Much of the red tape of official routine procedure that formerly delayed the work and disgusted able men has been done away with. Along with the day of bureaucracy has departed the day of the jack-of-all-trades; the skilled specialist has taken his place.

The Isthmus wants men who can do things, and promotion for such men is rapid. At the machine shops at Gorgona and Cristobal the men at work with the pneumatic riveters and portable cranes, the lathes and steam hammers, are men specifically trained in the use of such tools. It is safe to say that for a long time to come no boiler-maker who is good for anything will be turned away from the Isthmus. Men are bringing their families to the Zone, confident of finding congenial society for their wives and adequate tuition in the Zone public schools for their children. The quarters provided by the Commission are comfortable, well-lighted and well-ventilated.

Going to the Isthmus, as I did, in the spirit of independent inquiry and the desire to get at *what's what,* I was quite ready to approve the findings of the "muck-rakers," in so far as their findings should prove true. But I cannot provide the reader with a sensation, when the material for the sensation does not exist. Landing at Colon, we found some of the streets paved with vitrified brick, and cement sidewalks being laid. There are hydrants at intervals of 700 feet, supplied by the (520,000,000-gallon) Mount Hope reservoir. We found an 80-foot roadway building to the cemetery at Monkey Hill (rechristened Mount Hope). We found a bakery, started the day before our visit, capable of turning out 24,000 loaves of bread a day, and a cold-storage plant and a laundry (capacity, 10,000 pieces a week) in process of construction.

Mr. Bierd (the able manager of the railroad) showed us at the Cristobal machine shops in Colon a track-shifting device he had just invented, which in 29 minutes throws 200 feet of track 3 feet 4 inches, with seventeen operations. The wharf at Cristobal has recently been lengthened 400 feet and roofed. A 20-stall locomotive round-house, and a car-shop to accommodate 110 cars, stand on a spot which a little while ago was a jungle full of rotting French machinery. A cinder-pit has been constructed and a coal-dock of the Great Northern type (20 per cent incline to pockets) erected. The entire mechanical equipment of the shops we visited at Colon and Gorgona was thoroughly up to date, except for the electric installation that will come with adequate water power.

A visit to the Mount Hope stores (across the railroad track from the Monkey Hill cemetery) shows a genius for classification and methodical arrangement on the part of its superintendent. In two buildings about 600 feet long and (together) 160 feet wide, are housed all minor French hardware which has survived climatic deterioration, and all new material purchased by the Commission for distribution to every part of the Isthmus. Here may be found all manner of hotel and house supplies and furniture, together with vast quantities of roofing tiles and fence materials, metal piping and hand tools of every description. Out in the yard are many carloads of French iron. Although every boat to New York, on the Panama line, carries a quantity of the French iron as ballast, there is much material that is still serviceable, if not in its original form, at least when it has been worked up in the shops at Colon and Gorgona. I could not see that there was unnecessary red tape in this system of classification and distribution of supplies at Mount Hope. Some such method is absolutely necessary in the handling of such enormous

quantities of material. A great change has been wrought since, three years or more ago, a surveyor whom I knew had to wait six weeks to get his instruments out of the government storehouse.

THE CANAL COMMISSION STORAGE DEPOT AT MOUNT HOPE.
The largest on the Isthmus, being the main stores through which all supplies are distributed.

Perhaps the greatest need of the Zone at the present time is for the complete double-tracking of the Panama Railroad. At certain points, three or four tracks are needed. As I rode in the locomotive cab from Colon to Panama, the inadequacy of the present facilities was borne in upon me. Here and there the embankment is ready for the rails, and in places a second track has been laid for a short distance. Cypress ties, imported from the United States, are scattered along the road bed. Some of the old lignum vitæ ties have lasted ever since the railroad was built. The French rails were only from 19 to 24 feet long, as compared with the 30 to 33-foot rail of American practice. What with occasional specials like our own, and the dirt-carrying trains from the Culebra cut en route to the dumps, it is a marvel that the regular schedule of three trains a day each way (47 miles, with many stations, in 2½ hours) is so little interrupted. It is necessary at present to run ten passenger-cars to a train, and more trains cannot be put on till there is at least one additional track. The negroes have developed a mania for riding to and fro between the towns, "visiting." It costs a white man $2.40 to cross the Isth-

mus first-class, and a negro half that amount for second-class accommodation (he may ride first-class if he chooses). The locomotives are from the American Locomotive Company—forty new Baldwins are coming to the Isthmus presently. A few of the little Belgian locomotives are still in use, but they can only handle the small French dump cars, and the big vestibuled dirt trains with the Lidgerwood drum-and-cable plow unloaders are beyond their capacity.

At present about a thousand Italians and Spaniards are coming every month to Panama as laborers. The Gallegos—Spaniards from northern Spain—and the natives of southern France, are admirable workmen. The negroes from Jamaica and Barbados, Trinidad and Martinique, have not on the whole proved satisfactory. Though tractable, they are lazy, and when they have earned a little they are likely to build themselves shacks in the forest and desert the work.

A WARD IN THE COLON HOSPITAL.
The two large hospitals are at Ancon and Colon.

They have a wonderful command of English, and a Beau Brummel urbanity of manner. They find the Ancon Hospital a kind of earthly Paradise, and are such docile patients that the nurses—even the Southerners—would rather have a ward of the black men than of the more captious and restive white employees. It was decided, while we were on the Isthmus, not to make use of the Chinese in canal construction. The question of Mongolian labor on the Isthmus has

STEAM DRILLS WORKING IN BAS OBISPO CUT.

been the subject of rather heated discussion. But the Chinese workman on the Isthmus would never have come (if we must speak in the past tense) into competition with American labor. Situations in the machine-shops and with the steam-shovels, in the offices and the draughting-rooms, or official positions that entail intelligent supervision of less highly qualified labor—these are the positions appropriate for the white American, and these are the positions he will fill.

The spoil from the Culebra cut (Bas Obispo to Pedro Miguel) is costing at present about 72 to 93 cents per yard, for final disposition. The cost for October (toward the end of the rainy season) was 76 cents. This is merely the cost of excavation plus that of the haul to the dump, and does not include any proportion of general charges such as the outlay of the Comimssion in sanitary work and in building quarters for laborers. Since the President's visit, heavy rains on December 2, 3, and 4 flooded the Culebra cut so that no work could be done for a week. The tracks of the railroad at Matachin and Frijoles (points outside the cut) were flooded to a depth of 4, 6, and 8 feet. Yet on December 10 the daily-output record was broken. The roadbed was in such good shape that it was easily put in commission again. There were no serious landslides in the cut. This episode demonstrates a recuperative capacity which the working-plant on the Isthmus has never until now possessed.

The performance of steam shovels 227 and 229 in the rock cutting at Bas Obispo, is perhaps the most convincing object-lesson for anyone who may be inclined to call in question the vigorous prosecution

of the canal enterprise. The rock here is of the hardest. In contrast to the indurated clay at Gatun (which breaks in the fingers like slate or even sandstone), the rock at Bas Obispo is basaltic trap-rock which requires to be thoroughly "shot" (blasted) before the steel-toothed buckets of the great 95-ton Bucyrus shovels can handle it. These are the most powerful digging-tools in existence. I got up on the crane of 229 to watch it at work. There are 63 shovels at present in operation on the Isthmus (40, 70 and 95-ton). In soft work, as at Gatun, the 70-ton shovel is preferred, as having the quicker movement. At Gatun, the excavation for the locks has been started with two 70-ton shovels. The delay has been due to the thoroughness with which borings have been taken over the entire site of the dam and the locks at that point; 500 borings were made—about 200 of them on the actual lock-site—one boring for every 200-foot square.

Standing on the hill above the station at Gatun one gets a very clear idea of the location of the great dam which, next to the excavation of the Culebra cut, is the *crux* of the engineering problem. The little village of Gatun lies at one's feet, at the confluence of the Chagres and the old French canal. It is a cluster of perhaps a hundred little shacks, with a wooden cross-surmounted Catholic church conspicuous in the midst. The dam, more than half a mile through at the base, will completely obliterate the village site. It extends from the hill whereon we stand, across the valley, 7,900 feet,

GATUN, WITH THE CHAGRES IN FLOOD, NOVEMBER, 1906.

with a single angle, to a corresponding point in plain sight on the hill that forms the opposite wall of the valley. Its cubic contents will be something like 22,000,000 yards. This great earth dam, with its crest 135 feet above sea-level, and thus 50 feet above the surface of the 85-foot lock level, is not of an unprecedented type. The San

NEAR BAS OBISPO, DECEMBER 8, 1906.

Leandro dam, built by the Contra Costa Water Company to supply water to Oakland, California, is an earth dam 120 feet high; and the Pilarcitos dam, 95 feet high, has stood for forty years; this latter dam was built by the Spring Valley Water Company to supply San Francisco. The north dike of the Wachusett Reservoir in Massachusetts is two miles long, and is planned to have 65 feet of water against it. With a bottom width of 3,100 feet and a top width of about 360, there need be no fear for the stability of a dam of earth at Gatun.

The material in which the three (duplicate) locks at Gatun are to be built is indurated clay. The lock flight will all be comprehended within the distance of slightly under a mile. The masonry work, in reinforced concrete, it is hoped will be begun in a year or a year and a half. The time of completion of the canal is of course conditioned on the Culebra excavation and the construction of the Gatun dam, but it is evident that in building an earthwork of such magnificent

proportions it was a necessary preliminary to assemble abundant data from a large number of borings.

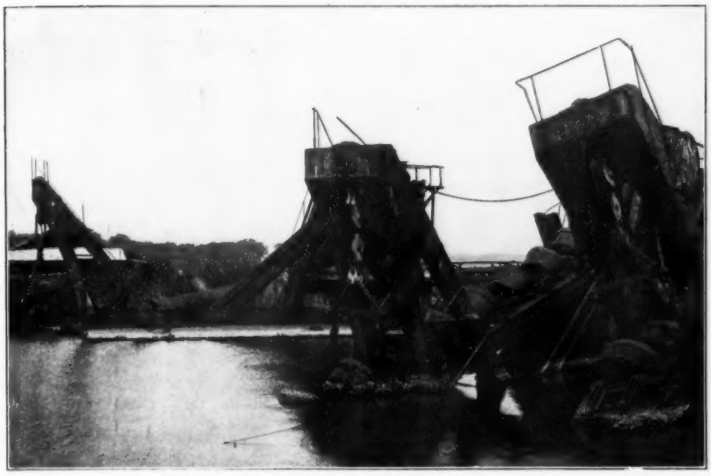
At Culebra—that is, at the summit, between Gold Hill (660 feet) and the opposite eminence (450 feet), the French have cut down the saddle from its original 325-foot level, until from 90 to 130 feet of vertical distance is left to be cut down in order to reach the bottom of the proposed lock canal (i. e., a point 40 feet below the surface of the 85-foot lock-level canal). The work of the Commission has been altogether confined to the sides of the cutting. Along the entire length of the cut, from Bas Obispo to Pedro Miguel, some 26 shovels are at work. On each shovel from 3 to 5 dirt-trains are in attendance, and the rapidity of execution of each shovel of course depends on the rate at which the spoil can be hauled away. A 70-ton shovel with a 3-yard bucket can under pressure fill a Western dump-car in a minute and a quarter (seven bucket-loads). The average time required to fill a ten-car dump train, allowing for delays, is about half an hour.

PAVING A PANAMA STREET WITH BRICK LAID ON CONCRETE.

The city of Panama since the American occupation of the Zone has been completely transformed. About 5,000,000 brick have been brought from Dubuque, Iowa,—costing perhaps $8 or $9 per thousand in the United States,—and laid, in cement, on the principal thoroughfares. Some of the side streets have been merely macada-

mized. The result is that Panama now boasts the best paving of any city in the northern half of South America. The houses, of the mission order of architecture, with the second story projecting, crowded together along the narrow streets, look like the stage-setting of second-rate light opera. On the side of Ancon Hill, just outside of Panama but within the Canal Zone, the greatest surprise of the trip awaited us. Here we found, in the Tivoli Hotel (owned by the Isthmian Canal Commission) a hotel that in every respect equalled the first-class hotels of American seaside resorts. There was mission furniture, a telephone in every room; there were tiled bathrooms with shower-baths, and electric lights, and there was a ball-room where the New Year's dance of the Culebra Club took place. This was a good chance to study the *personnel* of the American community. It appeared to striking advantage. The many attractive, well-dressed young women, and the young men in conventional evening attire—the entire company numbering perhaps four hundred, from all parts of the Zone—danced to the music of an orchestra of eight pieces, precisely as the people at home would do on a similar occasion. Indeed, the American army of peaceful occupation seems to have transferred its modes of living—its ethical and social code—its recreations and pursuits—to the Isthmus, very slightly altered. There is a keen rivalry for the baseball championship of the Zone, which may in time wean the native population from their ruling passions of the Sunday morning lottery-drawing and the Sunday afternoon bull-fight.

An unexpected delay of a day in the departure of the steamer gave us a chance to go off the beaten track, into the interior, and see something of the conditions of native life, and take part in an alligator-hunt—a typical Isthmian recreation. We started from the Tivoli Hotel at 3 a. m. in wagons for La Boca, some three miles distant, where we found awaiting us a 50-foot French launch that was discovered in two pieces at the top of the Culebra divide and put together by the Commission. In this launch we went some twenty-five miles westward along the Pacific shore to the mouth of the Chorrera river, where an English trading-company has built a masonry dock. Here we got into four small rowboats, with Jamaica negroes at the oars, and fought slowly upstream against the seaward-setting tide. After two miles of it, we thought we should have to give over the effort, for we came to a little rapids where the current of nine miles an hour poured through oyster-clad rocks with a drop of a foot or two. Finally we all got out on the encrusted basalt rocks and



ABANDONED FRENCH MACHINERY AT COLON.

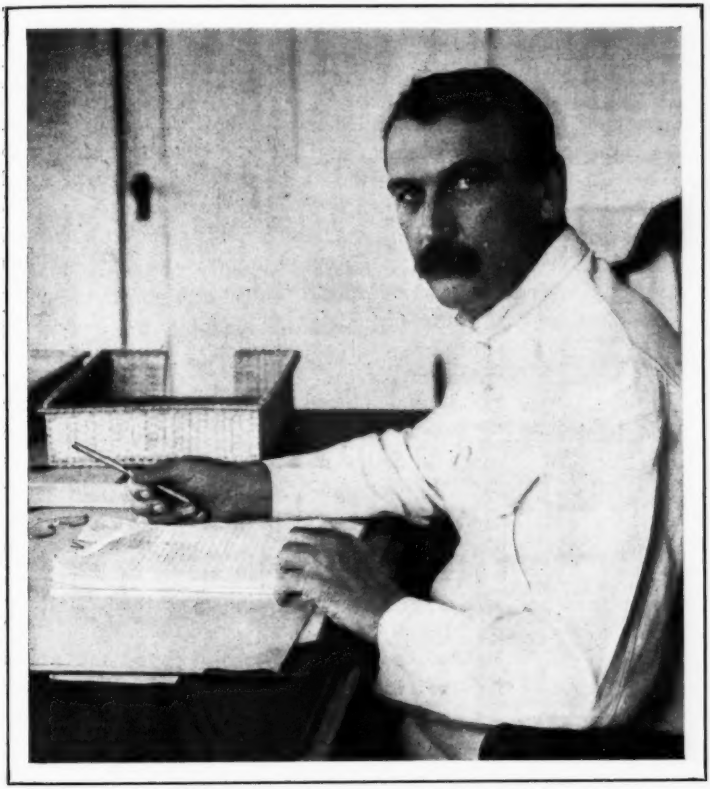
cracked unpleasant oysters while the boatmen, their trousers rolled high above the knee, managed to drag the boats across where the coffee-colored stream was shallowest. As yet we had seen but three 'gators—one on the bank at the river-mouth, and the others nosing the ripples as they slowly swam across the stream ahead of the launch. But suddenly, as we rounded a corner, it was like tumbling into the tank at the Zoo. The whole left bank of the stream seemed sliding into the water at once, as a mass of the gray-green saurians found their pudgy legs and shambled and slumped into the water from off a shelving bank of mud. We saw a great many snipe, some whistling ducks, and a blue heron, and the strident voices of parroqueets filled the woods like gramaphones run amuck. There are numerous small wild deer on the Isthmus, three kinds of monkeys, and every smaller variety of *genus felidae* can be found in the jungle. The water at the mouth of the Chorrera danced with mackerel, and there is splendid sport awaiting the expert fisherman along the coasts of the Isthmus. It is hard to get good fish at Colon and Panama, owing to the inertness of the inhabitants (though we saw one fishing-party of forty in a boat meant for ten), and the fish course at dinner is usually conspicuous by its absence. Perhaps the fear of leprosy, and the ascription of this dread disease to a fish diet, has frightened the natives, and caused them to give over the fishing to the pelicans that sit, as solemn as dachshunds, on the edges of the rocky islets of the Gulf of Panama.

To our surprise, we found no theatre worthy of the name in the city. A cinematograph was the nearest approach to a dramatic entertainment. The automobile has just made its *début* upon the Isthmus: a thirty horse-power Mercedes (without a license number) graced the vitrified brick in front of the Presidency, during the Friday evening reception, and the city boasts one other machine, owned, I think, by the same plutocratic individual. Several "automobiles" travel to and fro along the railroad, in connection with the canal work. I noticed three motor-cycles plying about the streets. A "rubber-neck wagon" company is being formed for Seeing Panama, and the Panama Banking Company is back of an electric trolley line, the route for which has already been surveyed. It will make money, for if ever there was a community that loved to be wheeled about, it is the citizenry of Panama.

The sole factory chimney in the city appertains to the ice-plant, but on New Year's Eve the Old Year was ushered out by a very proud showing of steam whistles. The DeForest Wireless Company has a station at Colon, but in the climatic conditions that obtain it does not yet work with entire success. One of their tall towers was blown down just before we landed, in a norther that kept the *Panama* and the (R. M. S.) *Tagus* waiting four days for a chance to dock.

We met President Amador, and conversed with him on the subject of Isthmian politics. He expressed a very natural relief in the unclouded prospect of no more revolutions, since the little Republic has come under the protection of her sinewy elder sister of the North. Before his election to the Presidency, Dr. Amador, as a practising physician, won the loving regard of a large portion of the inhabitants of Panama. He is an enthusiastic *connoisseur* of orchids, a man of culture and refinement, and yet the humblest barefoot citizen may come before him assured of a considerate hearing. His Friday evening receptions are not state affairs, but opportunities of meeting informally the Chief Executive and Señora Amador—a hostess of winning graciousness and personal charm.

The two chief figures on the Zone at present are the chief engineer, John F. Stevens, and the chief sanitary officer, Col. William Crawford Gorgas, U. S. A. Stevens is one of J. J. Hill's pupils: having learned to obey orders, he is able to command. They call him the "Sphinx," because, like von Moltke, he can be silent in seven languages. At other times he has Lincoln's consummate gift of story-telling. He is "a good mixer," affable and democratic, but at the same time woe unto the man who oversteps the boundary between freedom and license, and presumes upon the Chief's good-humor. The Chief



JOHN F. STEVENS, CHIEF ENGINEER, ISTHMIAN CANAL COMMISSION.

is accustomed to give his orders laconically, or, as one of his men put it, "Sometimes his sentences are so damn short, he keeps me guessing." He knows what he wants, and does not fluctuate betwixt two minds in a matter. Consequently he has a corps of subordinates who will do anything he tells them, and follow him anywhere. They trust his great railroad experience and engineering ability, but more than that, they believe in the man he is. A great part of John F. Stevens' power (with all due reserve and respect be it said) is ascribable to the fact that Mrs. Stevens is a woman of large-hearted maternal sympathies, to whom any young man may come (and lots do come) when in trouble, sure of finding a counselor and a friend.

Dr. Gorgas is as mild-mannered and unassuming as any man who ever honored the shoulder-straps of an American army-officer; but

his accomplished task is one that has left every human being on the Isthmus his debtor, for the conditions which make life tolerable and perfect physical vigor for a white man in the tropics possible. He is the man who more than any other has ensured the consummation of the canal project. The French failed because they had no Dr. Gorgas. When "the tumult and the shouting dies" and it is made clear who are the real heroes of Panama, the name of Dr. Gorgas will stand near the head of the legion of honor. I spent more than three hours in the wards of the Ancon Hospital, which is his chief outward and visible monument. The hospital is amply equipped with every modern device for antiseptic surgical treatment, and for sterilizing, and possesses a first-rate X-ray machine. The nurses are a splendid set of women, and the doctors are men of experience and ability. Dr. Carter, a yellow-fever expert, is the best informed botanist on the Zone. Ancon Hill, where the Hospital and the Tivoli Hotel are located, is perhaps the most desirable portion of the Zone as a place of residence. Real estate in and around Panama, I may remark, is rapidly rising in value; in Colon land is appreciating still more rapidly.

When 30,000 white and black people, many of them unused to tropical conditions, have to be housed and fed and watered, while at the same time one of the greatest engineering undertakings of the centuries is being prosecuted, it cannot be expected that as much will be done in actual canal-building as will be accomplished later when the 30,000 have become thoroughly settled and acclimated, and have adapted themselves to the new mode of living, so that undivided attention can be given to the engineering proposition. The excavation for the year to December 1, 1906, during which time no extra effort for a yardage-record was made, was 1,500,000 cubic yards—just about twice the output of the preceding year. In August, 1906, about 250,000 yards, in September 300,000 yards, in October 325,000 yards were taken out—and these months are all in the rainy season, when the work is carried on under the greatest difficulties. There is no reason to be discouraged at the showing, and only a person who has been on the ground and seen for himself the situation can realize the true significance of the figures as an index of what has been accomplished. It is to be wished that those critics who are impatient of delay, and whose slogan is "Make the dirt fly!" would go to the Isthmus and stay there long enough to see what has been wrought: then it will seem to them as though in a little while a very great deal has been done.

THE CHOICE OF MOTIVE POWER FOR THE WORKSHOP.

By R. E. Mathot.

II. COMPARATIVE RUNNING COSTS OF STEAM, GAS, AND OIL ENGINES.

Mr. Mathot's series began in our January issue, the first portion being devoted to questions of comparative first cost of installations under the various systems discussed. In this section he takes up their relative requirements in the way of operating conditions and running expense. A third part will conclude the review with a summing up of overhead charges, and a group of illustrative working examples.—THE EDITORS.

IN a preceding article we have considered the relative demands of the steam engine and the internal-combustion motor in various types so far as these apply to the first cost and installation of the motive power. It remains to carry the same comparison forward to the operative conditions; and first among these, following the general scheme outlined last month, we may take up the consumption of water, of oil and of fuel.

The Consumption of Water.—The quantity of water required by steam engines and turbines varies greatly with the type of the machine and the horse power it develops. It lies generally between 7.5 pounds and 37.5 pounds per horse-power hour, as indicated in the comparative table inserted in the preceding article.* To this must be added the water required for condensation, which, with jet condensers, is practically 3¾ gallons per pound of steam used in the cylinders. A Corliss engine of 100 horse power, for example, working under full load on a steam consumption of 17½ pounds per horse-power hour, will require a total water supply of about 6,800 gallons in the same time.

Such an expenditure for water could not be contemplated unless the engine is installed near to a pond or a water course. When a condensing installation necessitates long piping, the boring of a deep well, or the introduction of a series of pumps with cisterns and reservoirs, it is generally preferable to have recourse to cooling arrangements. The same water is thus used over and over, and it is necessary to add enough only to compensate for leakage, evaporation, priming, etc.—a demand which will scarcely exceed one gallon per horse-power hour. The condensed steam will carry with it drops of oil, which, collecting gradually in the apparatus and in the

*THE ENGINEERING MAGAZINE, January, 1907, page 499.

tanks, would cause trouble. It is therefore well to introduce an oil separator.

A single-acting gas engine, regulated by variable admission and supplied by a suction producer, requires a water supply of about 7 gallons per horse-power hour for the cooling of the motor, of 4 gallons for the washing of the gas and the scrubber, and of about one pint for the vaporizer of the generator. This makes a total barely exceeding 11 gallons. An engine of 100 horse power under full load will therefore require but 1,100 gallons an hour—that is to say, about one-sixth of the requirement of the steam engine of equivalent power with a jet condenser wasting the water of condensation. Further than this, there rests the possibility (as in the case of the steam engine) of reducing the consumption of cooling water by employing a cooling tower. In the case of extreme scarcity of water, it would be possible, also, by adopting certain methods of purification, to re-employ indefinitely the same washing water. This carries in solution certain ammoniacal salts, sulphuretted hydrogen, and sometimes sulphurous acid, which oxidizes to sulphuric acid.

In the double-acting gas engine the quantity of water necessary for cooling is slightly increased. The cylinder, cylinder heads, and valve boxes require about 7 gallons, and the piston and rods about 2¾ gallons per horse-power hour. The water should be supplied under a pressure of at least one atmosphere.

The use of cooling arrangements is generally to be recommended for motors or engines of a power higher than 50 horse. The continuous use of the same water practically avoids the trouble with scale, which almost always occurs when the cooling water is wasted. This scaling is more or less abundant according to the character of the water; it obstructs the circulating passages, adhering closely to the metal and hindering the transmission of heat. It may also start corrosion of the joints or of the plates or cause the rupture of the steel castings. It therefore involves, in the attempt to escape these troubles, constant expenses of upkeep, such as those occasioned by the frequent disassembling of the apparatus for cleaning, or the use of chemicals to remove the calcareous impurities or to prevent their adhesion. In large boiler installations it is common to employ special purifying apparatus in order to remove completely the troublesome salts dissolved in the water. This may well introduce an item of cost relatively important, but higher for the steam engine than for the gas engine because the former requires a much larger quantity of water for its operation.

The Consumption of Oil.—This item is practically the same for the gas engine and for the steam engine, and varies between 3 and 4 grammes per horse-power hour. Of this quantity the cylinder of an internal-combustion motor takes about 1 gramme, the typical lubricant being a special mineral oil having a burning point not lower than 180 degrees centigrade and a density of 0.880 to 0.890 at 17 degrees centigrade.

Semi-portable engines, on account of their high rotative speed, demand freer lubrication than stationary engines whose speed is lower. Turbines have but few parts requiring lubrication and their consumption of oil is lower than that of either of the preceding types.

The Consumption of Fuel.—If we place ourselves at the viewpoint of the lowest consumption, the combustion engine operating on producer gas stands incontestably first in line, with a mean figure of 400 grammes (0.88 lb.) for powers between 30 and 100 horse. It is fair even to note that certain installations have claimed a consumption of but 300 grammes (0.66 lb.) but I do not mention this figure except by way of memorandum, as it is at present exceptional. It is nevertheless certain that the improvements daily introduced into the construction of motors and producers will cause the average figure of consumption to drop very rapidly below 350 grammes. Care must be taken in comparing the gas motor with the steam engine to take the figures of consumption per effective horse-power hour in both systems; for it is customary with the steam engine to consider indicated power rather than effective power, and consequently under this head confusion might easily arise.

Semi-portable engines, in which a high degree of perfection has been reached during the last few years, take second place; then come successively stationary steam engines and turbines, according to the power developed and the care used in their construction.

With steam engines the skill of the fireman exercises a large influence upon the total fuel consumption, and differences of 10 to 20 per cent have been shown between the work of one fireman and that of another. With producers, on the contrary, this factor is inconsiderable.

The group composed of stationary reciprocating engines or turbines, with the boilers separate, is necessarily less economical than the semi-portable unit, because it is always subject to losses inherent in the arrangement of the boilers and steam piping.

The advantage accruing to the gas engine from its minimum consumption of coal is partly offset by the fact that the quality of

this coal must be special, and that its price may sometimes rise to double that of an ordinary fuel fairly well suited for use under the steam boiler. It is therefore necessary in every case, in weighing the choice between the two types of prime mover, to consider the figures obtained by multiplying the quantity of combustible consumed by the price of that combustible at the point of use. I must add, moreover, that all manufacturers of producers at the present time are endeavoring to turn out apparatus capable of utilizing the smaller grades of anthracite and even various kinds of coal other than the lean coals. Important progress has already been made in this direction and there seems to be no doubt that the desired results may be obtained in the near future. So far as concerns the pressure producers, I might mention notably apparatus of the Duff, Mond, or Dowson types, which can utilize bituminous fuels of very low value. Oil engines with high compression and combustion of the Diesel type, in both vertical and horizontal models, have also entered upon the practical stage of application; and they rival the older types of prime movers from the point of view of fuel consumption. Their builders guarantee, in fact, that under full load this will not exceed 190 grammes (0.42 lb.) of crude petroleum per horse-power hour. The cost of this on the continent of Europe is about 0.07 francs per kilogramme (⅔ of a cent, or ⅓ of a penny per lb.) which brings the running expense down to 1.3 centimes—say one-quarter of a cent, or half a farthing—per horse-power hour.

Disposal of Waste.—The residues or waste material, for which, so to speak, constant provision must be made in a power plant, include ashes, water or steam, gas and smoke.

The ashes to be taken away from a steam boiler or a producer represent respectively from 10 to 15 per cent and from 6 to 9 per cent of the total quantity of fuel used. To take a concrete example, this would give in an installation of 100 horse power, working at full load, the following figures:

Stationary steam engine. 31 lb. ashes per hour from 253 lb. of coal burned.
Semi-portable steam engine. 17½ lb. ashes per hour from 133 lb. coal burned.
Gas engine with suction producer. 6½ lb. of ashes per hour from 88 lb. coal burned.

Steam boilers and gas producers both require cleaning of the grates once or twice daily. This operation involves for the former a drop of pressure and for the latter on admission of air which depreciates the quality of the gas.

Water and Steam.—Non-condensing steam engines are provided

with an escape pipe discharging freely into the air. The exhaust steam issuing from these is dissipated in the atmosphere, leaving no further trace than possibly spattering drops of water and particles of oil, against which protection is easy.

Steam engine with jet condensers involve the handling of an important quantity of waste water. General figures of the volume have been suggested in the first part of this article. This water may be returned to the water course or the pond which serves as a feeding reservoir to the condenser. It is sufficient if care be taken to discharge the hot water down stream from the cold-water intake, or at a considerable distance from it.

In the case of gas producers, it is necessary to provide for the removal of a relatively large quantity of water which has served in the scrubbers for washing the gas. As heretofore stated, this water contains in solution ammoniacal salts, sulphuretted hydrogen, and sulphurous acid, which is susceptible of transformation into sulphuric acid. It is therefore necessary to avoid discharge of this water through pipes or into vessels of zinc, as this would be immediately attacked. Even iron will be oxidized quite rapidly if the proportion of sulphuric acid in the water is at all considerable. In out-of-town installations, where drains have not been laid, this water must be allowed to flow away on the surface. From this, however, results a disengagement of odors which may give rise to damage claims on the part of neighbors and which may become a very serious inconvenience in the case of large installations.

The water used for the cooling of a gas engine need not involve any loss by waste if there is a cooling installation, which I advise for any power plant of more than 50 horse power.

Gas and Smoke.—Large boiler plants give rise to the production of a great volume of smoke, particularly at times of firing and when a bituminous coal is employed. The construction of tall chimneys permits the discharge of the smoke into upper layers of the atmosphere, but this disposal is far from being perfect. This may easily be noted in any industrial center, where the whole atmosphere is fouled by the cloud of chimney smoke and by the dust and soot which it carries. Many manufacturing establishments have tried, or have been compelled, to introduce smoke-consuming apparatus of various types to dispel or at least to reduce this nuisance. This apparatus, however, in general, gives but mediocre results. Gas engines and generators produce no smoke, because all the products of the chemical reactions taking place in the interior of the producer go direct to the cylinder

of the motor, where they undergo complete combustion, leaving as residual products colorless gas carrying no soot in suspension. Only at the moment of firing up, during the period of blowing, does a very little smoke discharge through a special chimney connected with the apparatus, but closed off as soon as the motor is started. Nevertheless pressure producers blown by steam do generally involve the installation of a little boiler, which involves to some extent the nuisance of smoke production, but to a relatively small degree.

Further, I just said that the gas escapes quite invisible from the exhaust of the motor. If the combustion is perfect, it may also be odorless; but it issues from the escape valve with considerable noise and it is necessary in certain cases to provide for muffling this. The result is secured sometimes by two cast exhaust pots placed close to the motor or by a single exhaust pot near the motor and a muffler at the outer end of the exhaust pipe.

Local Conditions, Neighborhood Restrictions, Legal Regulations. —The local conditions which must enter into consideration when the type of a projected power installation is determined are many and of various kinds. So far as concerns the power plant *per se*—its first cost and economical maintenance—the question of water plays a very important *rôle*. Note should therefore be taken of the character of the soil and of the abundance or scarcity of possible underground supply. If the installation includes a cooling tower, the buildings must be disposed so as to permit free access of wind and air to this apparatus. Altitude must also be taken into consideration, as it influences the power of gas motors through the fact that increase of altitude means progressive reduction in the density of the combustible mixture. It may be estimated that each 100 metres additional elevation causes a loss of 1 per cent in the power output of the motor.

The question of transportation, of fuel storage, and of the costs which these factors involve, is also highly important. In some localities the total of these charges is greater than the cost of coal at the pit mouth. Such conditions would indicate *a priori* the desirability of installing the type of machine which would require the smallest quantity of fuel.

The position of the power plant in relation to surrounding neighbors is also a point to be studied. Occasion might be given for damage claims on account of smoke, noise, vibration, offensive odors, the discharge of waste water, etc.

Each type of apparatus, when regarded in this light, may be found to involve one or other of these disadvantages specially characteristic

to it. The means of remedy should also be examined for every case, and the attendant expense should be taken into consideration. Individual peculiarities belonging to certain undertakings may indicate clearly that some particular type of motive power must be wholly rejected. For instance, in a silversmithing establishment it would be unwise to employ a gas engine fed from a pressure producer, because the exhaust of carbonic acid containing sulphuretted hydrogen would blacken the silver. A suction producer might give rise to less difficulty in this particular point. Nevertheless, the gas which escapes during the blowing, when the apparatus is started, might cause the same undesirable phenomenon. It would at least be necessary in any case to take special precautions and to provide active ventilation in the engine-room to prevent the diffusion of noxious gases.

Finally, careful observance should always be given to official rules and regulations or ordinances governing industrial installations, and all requisite provision should be made to assure safety in operation and to avoid any nuisances of which outsiders might complain. So far as boilers are concerned, it is almost everywhere now requisite to arrange them conformably to technical rules laid down by the proper authorities and to submit them to periodical inspection. Gas engines and producers, which are of relatively recent application, have not yet been generally brought under well-established regulations. The nuisances to which they may give rise should nevertheless be kept plainly in view. Pressure producers, in particular, are attended by certain dangers of explosion and of gas poisoning. Among several installations of this sort made in Belgium, I know of three in which the gasometer blew up. The cause, of course, is an error in operation by which this receiver is allowed to fill with a mixture of gas and air. If, under such conditions, the gas is lighted at the end of a pipe near the gasometer, there may be a "backdraft" of the flame into the interior of the receiver, causing the explosion of the detonating mixture there contained.

Suction producers are exempt from danger of serious explosion, because they do not carry any reserve of gas. Nevertheless, when the motor has just been stopped, care must be taken in opening the generator, whether by the fire-door, the ash-door, or either of the hand holes of the hopper, not to stand opposite the opening, for there is almost always a slight deflagration, caused by the sudden inrush of air into the apparatus. In large producers the further precaution is taken of arranging so that these openings can not in any case be uncovered simultaneously.

The suction producer carries little danger of carbonic-oxide poisoning. The gas is produced, in fact, under vacuum and can not escape outward. In pressure producers, on the contrary, there may be leaks allowing the continuous escape of carbonic oxide. These appliances and the connecting piping should therefore be installed in places which are thoroughly ventilated and aerated.

Operation and Maintenance.—The cost of operation and of upkeep includes the consumption of water, of oil, of fuel, and of various supplies; the salary of employees—engineer only or engineer and fireman in the case of steam engines, and engineer and assistant in the case of gas engines. Note should be made of the fact that as the gas-power installation does not need to be charged oftener than every hour or every two hours, the continual attendance of a workman is not necessary with it, as it is with the boiler plant. Consequently, in the estimation of wages one may make a proportionate reduction in favor of the gas plant, corresponding to the work which the engineer may perform outside of attendance upon his motor. In general, the presence of the assistant is necessary at the time of starting and of cleaning the fires, to bring the necessary coal supply to the generator.

Upkeep and cleaning may be placed at 3 per cent of the cost of the installation for gas engines and semi-portables, and at 2 per cent for stationary steam engines. To facilitate comparison the interest on capital employed and the sinking fund should be apportioned over 300 working days of 10 hours each.

In the matter of cleaning the following points should be observed:

Steam boilers should be cooled and emptied about every three months and inspected internally for the removal of mud and scale, and externally for cleaning the soot out of the smoke passages. Advantage should be taken of this stoppage for the examination of the steam engines, and the inspection, and if necessary the replacement, of joints and packings. Once a year a critical examination of the boilers should be made so far as concerns the condition of the plates, rivets, and other portions subject to deterioration.

Producer-gas motors need more frequent inspection than steam engines. The admission valves should be opened and cleaned two or three times weekly. The piston should be removed about every two months, and every day at the time of starting assurance should be made that all parts of the engine are working normally and without friction. The pipes carrying gas should be cleaned once a year. Annually, also, the coke of the scrubber should be replaced, and the refractory lining of the generator should be repaired or renewed.

THE RELATION OF INSPECTION TO MONEY-MAKING SHOP MANAGEMENT.

By A. D. Wilt, Jr.

The large place which the inspection system occupies in modern specialized manufacturing will be readily acknowledged. Mr. Wilt is a practical specialist in the subject, and his article represents the principles and methods he follows in his regular work. He is actually engaged at the moment in introducing them into the shops of one of the large and successful industrial organizations of the United States.—THE EDITORS.

INCREASING complexity of modern invention, and the establishment of the theory that permanent commercial success can be achieved only through the superior quality of a manufactured article—through "delivering the goods"—has brought about a corresponding increase in the necessity for careful inspection.

Other changes have contributed, among which the more important are the development of the motor industry, in which danger through defective material or workmanship must be eliminated, and the introduction of wage systems in which quantity must not be secured at the sacrifice of quality.

While the necessity of inspection depends to a certain degree upon the nature of the product, it is a question as to just how far, when, and where it pays to inspect—as to whether it pays to inspect each component part minutely, as to how often a part should be inspected, and as to where it should be inspected, in a central inspection department or otherwise.

The possibilities and scope of a system of inspection have enlarged greatly with the development of specialization. While formerly the chief aim of inspection was to prevent the necessity of hand fitting, the adage being that "an ounce of inspection is worth a pound of fitting," an up-to-date inspection system is planned to accomplish a varied number of ends, among which the following are the most frequently sought:—

1. To prevent loss in prestige due to non-uniformity or defects in product which may cause accidents or delays.
2. To prevent necessity of hand fitting.
3. To prevent expense of replacing defective parts.
4. To prevent additional labor on parts already spoiled.
5. To prevent acceptance of defective raw material.

6. To pay workman only for good workmanship.

7. To prevent decrease in quality due to an increase in quantity caused by the introduction of wage systems.

8. To stimulate good workmanship through the moral effect of keeping records of defective workmanship.

9. To point out imperfections in machines and processes as well as in workmanship.

10. To point out proper allowance for unavoidable loss in making cost or price estimates.

11. To point out operations in which the workman must be better educated or instructed.

12. To stimulate good-will through fairness in fixing responsibility.

An inspection system may be operated for one or all of these purposes, but it may not always be devised so as to accomplish all of them. The inspection necessary to produce a perfect automobile, adding machine, or cash register, may be entirely unnecessary to produce one of the so called "tonnage" products, such as rolled steel bars or castings, or such products as cloth and leather. But nevertheless, the same principles of shop management are involved in every case, and can be applied in varying degrees to any class of manufacture. Upon the degree to which they can be applied—upon the certainty with which several conditions can be satisfied—depends the success of any plan of inspection.

Conditions which must be satisfied before it can be determined how far, when, and where it pays to inspect, are as follows:

I. Responsibility Must Be Fixed with Certainty.

II. The Price of a Rigid System of Inspection Must not Be a Loss of Good-Will.

III. The Authority of an Inspector Must End when He Has Passed upon the Quality of the Work.

IV. The Responsibility of Detecting Defects Must Be Placed on the Operator as well as on the Inspector.

V. Comparative Records Must Be Kept of All Appreciable Rejections.

The fulfilment of these five conditions is essential to money-making management. Each will be discussed in turn.

I. Responsibility Must Be Fixed with Certainty.

As inspection by its very nature points out defects, either in material, machine, process, or workmanship, it is obvious that locating

the cause of the defect is essential to good management. It is unnecessary to point out the evils of attaching blame to the wrong person, to prove that responsibility for errors must be fixed with certainty. This fixing of responsibility with certainty is not easy. The stock system is generally the vehicle for locating the source of the error, and a year is not considered any too long to install and perfect one which will do this with certainty. The establishment of a stock system with its accompanying safeguards is a subject for another article. *In general, any stock system should account for all stock manufactured.* Unless this is done—unless it is possible to discover at once just when, where, and by whom all operations are done—the responsibility cannot be fixed. The more complicated the product, the more difficult this is to accomplish. Where only one operation, machine, or workman is necessary to complete the product it is a comparatively easy matter. But simple or complicated, it is essential that the identity of each man's work be preserved until it has been passed on by the inspector.

Even after the inspector has detected the defect, the responsibility is not necessarily fixed. The error may be due to wrong instructions, imperfect gauges, or what not. In order to detect such errors, all instructions and specifications must be issued in writing. The slogan "Verbal Orders Don't Go" should be in evidence on all orders. This does not apply, of course, to general orders issued by a foreman to his men, but all orders from one department to another must be in writing before responsibility can be attached with certainty.

II. The Price of Rigid Inspection Must Not Be a Loss of Good-Will.

A plan of inspection could be operated which would simply detect defects, no effort being made to remedy the cause of the defects, or to bring any one to task for carelessness. Certainly such a system could arouse no ill-will. Such a plan, however, could accomplish but few of the benefits which may be derived from a comprehensive inspection system. It would not provide for paying only for good workmanship, it would not prevent a decrease in quality with an increase in quantity, it would not stimulate good workmanship, nor would it offer an opportunity for instructing the workmen how to correct their mistakes. So it becomes necessary, if full benefits are to be derived from a rigid inspection, to point out in the most effective way, but in a manner which will not arouse ill-will, the reasons for defects or errors.

If the policy for paying only for good workmanship is adopted, certain conditions must be satisfied in order to preserve good-will.

The defective work must be detected as soon after it has been spoiled as possible, and the responsibility fixed with certainty, for a workman must not be subject to deductions from his pay for work spoiled in a previous pay week, but must be assured of a fixed weekly minimum wage. The conditions under which the work was done must be as fresh in the operator's mind as possible, for he must have no doubts as to his responsibility.

Additional penalties, such as "docking" for spoiled material, or for extra labor on work which the operator should have known was already spoiled, should be attached only after cases of extreme carelessness.

If a workman is to profit by his mistakes, he must not be sworn at for them. Instead, advantage should be taken of the exceptional opportunity offered to instruct him how to remedy them. It has been my experience that it is harder to instruct the artisan, especially the mechanic, than any other type of individual, and that the best time to find him in a receptive mood, is when he is "caught with the goods," i. e., when he can be shown the result of his ignorance or carelessness. In fact, I believe that the best time to approach an operator on the subject of a new wage system is soon after he has made a mistake. Recently a very efficient foreman said to me after I had pointed out the value of instructing a workman when he had made a mistake: "You don't mean to say that an operator should not be 'given hell' for bad work? You know this is no Sunday School." I replied that it depended entirely upon his conception of hell, and that the modern idea is that hell is more a question of mind or conscience than of matter. The fact is that a workman of average intelligence does not have to be called down for bad work, with a proper plan of inspection. The moral effect of letting him know that records are kept of the amount of work he spoils, together with the policy of paying him only for good workmanship, is sufficient, and is accompanied with much less danger of loss of good-will than the plan of letting the inspector, foreman, speed-boss, or other authority, "raise hell."

III. The Authority of an Inspector Must End when He Has Passed upon the Quality of the Work.

It is apparent that the mere detection of the defects will not necessarily point out the cause of the defect. It may or may not point out imperfections in machines or processes, or it may point out operations in which a workman must be better instructed. It is consequently a question just how far the authority of the inspector should extend.

It is safe to postulate, at least, that his authority could cover the following functions:

1. That of detecting the defect.
2. That of detecting the cause—locating the responsibility.
3. That of prescribing the remedy.
4. That of administering the remedy—of disciplining or instructing the responsible party.
5. That of reporting the defect.

The function of detecting the cause—locating the responsibility—is not always an easy matter. The defect may be due to wrong instructions, blue prints or samples, or defective gauges. It may be due to defective material, or to some inherent fault of machine or process, or it might be too difficult a proposition to produce the product as planned. In fact, the operator might be responsible. So it is apparent that a very capable man is essential if the responsibility is to be fixed with certainty, if the most effective remedy is to be prescribed and the evil corrected.

The function of disciplining the responsible party in the most effective way is no simple matter, and in the two prevailing types of shop management, the military and the functional, cannot be well intrusted to the inspector. A long experience has taught us that we cannot very well serve two masters, so that both the inspector and the foreman or other boss cannot have the authority of disciplinarian and teacher.

The function of reporting the defect is a most important one, and if the inspector is trustworthy, this can obviously be done by him.

The question of the extent of the authority of the inspector, then, seems to depend upon whether or not an inspector can be secured with the qualifications for both detecting the defect and the cause. To do this, he must be honest, he must show no partiality, he must be quick and energetic (for under most inspection systems he will have great opportunity to "soldier"), and he must be informed as to all the requirements of the business, and know in many lines of manufacture the peculiarities of each customer.

If he is to attach the responsibility properly, if he is to discover imperfections in process or machinery, he must have qualifications almost equal to those of a superintendent. In classes of manufacture requiring a large number of inspectors, the difficulty of securing enough efficient men would prohibit the combining of the authority of detecting the error with that of detecting its cause. It is much safer, and more economical, to adopt some plan of inspection which will not

require such skilled inspectors. An ideal system of inspection is one which will enable the inspector to express his opinion as to the cause of the defect, and leave the duty of placing the responsibility and disciplining the men to a higher authority.

IV. The Responsibility of Detecting Defects Must Be Placed on the Operator as well as on the Inspector.

It has been pointed out that while the duties of an inspector should not include those of disciplinarian, the scope of an inspection system should be to do away with the necessity of a large amount of discipline, and still prevent a sacrifice of quality for quantity. But without other safeguards, bad workmanship cannot be reduced to a minimum. Defective work cannot be prevented with the best machinery, processes, or men, nor can additional labor on work already spoiled be prevented, unless the operator is supplied with full written instructions and means for inspecting his own work, such as gauges, blue prints, or samples, and is held responsible for the quality of his work.

It has been said to me, "Why, to do this we would have to employ a much higher grade of labor!" This would be necessary if no provisions were made for instructing the operator, but if advantage is taken of the opportunity to instruct him how to use a gauge or micrometer after he has spoiled some work, *for which he has been held responsible,* he will soon learn how to inspect his own work, and eventually develop into a higher grade workman.

There are certain classes of work in which it might not pay to have the operator take the time to do the inspecting. Such work is generally that which cannot be easily spoiled, and which can be done with great rapidity, such as rough grinding and polishing. As a cheap boy can be trusted to inspect such work, provided he is isolated from the operator, it sometimes pays to take chances by not having the work inspected while it is being done.

In order to compel each foreman to keep in touch with all work at hand, and to prevent one department from working off spoiled work on another department, where there is no intermediate inspection, I have found it essential to require each foreman to O. K. all work upon receiving it in his department, this being accomplished by providing a place on the shop ticket—the "bill of lading"—for his initials. In addition to this, the first piece operated on should be O. K'd by someone in authority. In this way the responsibility for detecting defects is shared by the foreman and operator as well as by the inspector.

V. Comparative Records Must Be Kept of All Appreciable Rejections.

Before the above general conditions have been satisfied, it is impossible to ascertain with certainty just how often it is necessary to inspect, at what stage in the process of manufacture it is necessary to inspect, and what is the best plan of inspection, for these points cannot be decided until it is possible to obtain reliable records of individual rejections which can be grouped for comparison. One or ten batches of defective work will not necessarily point out a defect in a machine or a process, or indicate what allowance should be made for unavoidable losses in making cost or price estimates. Records must be kept covering a long period of time and a number of rejections to be of value.

It has been said to me: "What is the use of keeping such records? You can look at the scrap pile and it will tell you where the trouble is. Furthermore, the inspectors know what stock is spoiled most frequently and where it is spoiled, so what is the need of a written report?" As a matter of fact, it has been my experience that information gathered from the inspector or the scrap pile is worse than no information, for it is generally misleading, especially where the product is the least complicated. A reliable knowledge can be gained only through statistics, for it is the *per cent spoiled through an appreciable period of time* which tells the story.

Just what data may be obtained in any class of manufacture depends upon the nature of the product, but in general an inspector's report should furnish the following information:

1. It should describe the part, giving its symbol number, order number, etc.

2. It should give the quantity made and the amount spoiled, stating the per cent defective.

3. It should locate the responsibility, by stating the department in which the work was spoiled, the date, the operator, the machine or process number, the workman's name and number, etc.

4. It should state the inspector's opinion as to the cause, and eventually the reasons of the foreman, together with his statement as to who is responsible.

5. It should state what disposition was made of the spoiled work, whether it was scrapped, repaired, made into another size, etc.

Such a form should be made out in duplicate. The original should be sent *with the rejected stock* to the foreman of the department in which the stock was spoiled, who *must show the workman* who

spoiled the stock how it was spoiled and how he can prevent future bad work of the same kind. The foreman must then fill in a brief explanation of the cause and state who is responsible. The original should be returned to the inspector *with the defective work.* After he has indicated its final disposition, he should return both original and duplicate, which he has held, to the superintendent's office. All material scrapped should pass through the inspector's hands, he only having the key to the scrap pile. Otherwise, all stock made cannot be accounted for.

The effect of this simple follow-up plan is remarkable. During the first week it was put into effect in several factories in which it was introduced, there was a decided change, not only in the quality of the work but in the attitude of the employees. At first it was taken by the workmen as an imposition, but soon they discovered that the responsibility was located without a doubt, and that they were not to blame for defects due to improper instructions, or machinery, processes or tools, *because it became necessary for the foreman to look carefully into the matter,* where before it was only too easy for him to lay it to the workmanship and let the matter drop. As the foreman has to show all appreciable rejections to the workman, the latter knows that he will be given a chance to clear himself. This, in addition to the fact that he is not "given hell," will cause anything but a loss of good-will.

The value of an inspection system is measured by the degree in which it brings to light fundamental defects in process, machines, tools—in fact, in methods of shop management and in the make up of the article itself. Such defects can be pointed out with certainty only by the data which it is possible to gather through a rigid system of inspection. These data from the inspector's report can be used in various ways, the use differing with the nature of the product. The comparative records in which it is used should be nothing more than a ledger account for each machine, process, operator, operation, department or other element, showing date, quantity and percentage of rejections. *It is the value of the inferences which can be drawn from such records by a capable manager which warrants the expense of an iron-clad system of inspection.*

True records will point out with certainty when, where, and how far it will pay to inspect. For example, in one factory for which I devised an inspection system, the records pointed out conclusively that the bulk of the defective work was rejected after the first operation. As it had been thought (guessed) that most of the work was

spoiled during the finishing operations, practically no inspection was given until after the last operations. The plan was immediately changed so that the close inspection was given after the first operations. In this way a large amount of money was saved in labor formerly put on work already spoiled.

In another factory where I introduced this plan, a ledger account was kept for each component part of a machine consisting of over twelve-hundred different parts. It was soon discovered that appreciable rejections were made of comparatively few parts. Steps were taken at once to change either the shape of these parts or the method of making them. Different milling fixtures were made for some castings, which greatly cut down the number rejected. New dies were made for several difficult punch-press pieces, the shape of some pieces was changed, and fewer rejections followed. Where formerly it had been the practice to inspect carefully each piece of a large number of parts of different symbol numbers, close inspection was given only to the few parts continually showing defects. Promiscuous inspection was given to a majority of the stock, and the capacity of the inspection department greatly increased without an additional force.

In order to watch the quality of workmanship of the several operators, the originals of the inspector's reports should be filed according to operators' pay numbers. If they accumulate under one man's number, either his workmanship is poor or something is wrong with his machine or process. If the duplicate inspector's reports are filed under machine or process numbers, imperfections will often be pointed out.

Through such records it becomes an easy matter to decide which is the most economical plan for operating an inspection system.

Plans of Inspection.

Many different plans of inspection have been devised which will accomplish some or all of the benefits that have been pointed out. Each plan must depend more or less upon the nature of the product. It would be impracticable to rely entirely upon a plan of centralized inspection in the manufacture of boilers or safes, but as many of such large products contain some small parts, it might pay to have both central and local inspection. It is therefore impossible to recommend any one particular plan for all classes of manufacture, so only the particular features of the plans in most general use will be pointed out.

Most of the plans of inspection are variations of one or more of the following:

1. Local inspection by traveling inspectors.
2. Local inspection by foremen.
3. Departmental inspection departments independent of department foreman.
4. The centralized inspection department.
5. The "chain" plan of inspection.

These plans will be considered only to the extent that the tests or conditions outlined in this article can be applied to them. Each plan has advantages not mentioned, and may be the only one applicable to a certain class of manufacture.

1. The Plan of Local Inspection by Traveling Inspectors.—The distinguishing principle of this plan is that each production center is visited by a traveling inspector. Either this plan, or that of having local inspection by foremen, is essential in the manufacture of large products which cannot be readily transported. Its chief claims for merit are the degree of certainty with which the responsibility can be fixed, and the celerity with which defects can be detected before extra labor has been added.

It has been pointed out why the duty of detecting the defects should be separated from that of detecting the cause and of disciplining or instructing the operator. The traveling inspector comes into very close contact with the operator, and it is almost impossible to limit his authority to merely detecting defects. It would be difficult for him to express an opinion in such a way as not to usurp the authority of the foreman, or speed or gang boss. It is also a difficult matter to compel a traveling inspector to turn in a report of all rejections.

It has been my experience that the claim that defects can be detected before extra labor has been added is seldom justified, for it is well-nigh impossible to secure enough trustworthy and energetic inspectors to "cover the ground" adequately. For example, in many classes of work, a tool or machine may get out of adjustment the minute after the inspector has O. K'd the work. This is especially true of screw-machine work, in which I have found it necessary to have at least one piece off every bar inspected if bad work is to be prevented or seams in the bar detected. As it would require almost as many traveling inspectors as operators to do this, the logical way is to provide each operator with test gauges, blue prints or samples, and hold him responsible for the quality of his work.

The point at which traveling inspection does not pay, is that in

which it becomes practical to transport the work to a central departmental or factory sinpection department. Even if traveling inspection is necessary, its expense and the impossibility of securing men with satisfactory qualifications discourages its general use.

If local inspection is essential, it can generally be advantageously accomplished by some form of centralized inspection. A combination of these plans will be discussed under the head of centralized inspection.

2. The Plan of Local Inspection by Foremen.—Some manufacturers have attempted to secure the benefits of traveling inspection by placing the whole duty of inspecting upon the foreman. This is practically the same principle as setting a thief to catch a thief, for as a foreman is partly responsible for the spoiled work in his department, it naturally is not to his interest to report all defective work. The many duties of a foreman generally prohibit his assuming the direct responsibility of inspecting, so sometimes the plan is adopted of having a small inspection department in each department.

3. Departmental Inspection Departments Independent of Department Foreman.—The inspector in this plan is generally not under the department foreman. The stock is inspected and counted just before it leaves the department. In this way the responsibility is fixed with quite a degree of certainty and celerity, and it is practical to have the duty of inspector end when he has located the defects. Its chief drawbacks lie in the difficulty of preventing collusion between the inspector and foreman. It also requires a capable head inspector in each department, and generally cheaper helpers, more of whom are necessary, and consequently the total cost much greater than if all were combined into one central department under one efficient head. It has been my experience that this extra cost is much greater than the cost of extra trucking involved in the central inspection department. Where local departmental inspection is practical, centralized inspection is generally practical, and the latter plan has marked advantages.

4. The Plan of Centralized Inspection.—It has become almost an axiom in factory management that the greater the centralization or specialization, the less is the cost of manufacture. While this does not necessarily follow in all cases, I have become convinced that it pays in the function of inspection. It pays because but one skilled inspector is necessary, for an inferior grade of labor can be employed to do the routine inspection, owing to the fact that the responsibility

of the inspectors is narrowed down to the simple duty of detecting and reporting defects. The chance for partiality is reduced to a minimum, and consequently the chance for ill-will, owing to the isolation of the inspection department from all other departments.

The chief claims for merit in this plan are its economy, its security from collusion, and the surety with which it supplies reliable records of all rejections.

On the other hand, it is not as effective in stopping defective work as the traveling plan, *unless the workman can be made to inspect his own work frequently*. The ideal plan of inspection is to furnish the workman with means for inspecting his own work, and then operate, as a check on this inspection, a comparatively small central inspection department. Such a department will have the effect of the "big stick," and a promiscuous inspection will be sufficient in most cases to detect all defects not discovered by the operator.

5. The Chain Plan of Inspection.—The "chain" plan is practical only in the manufacture of such products as will permit of a sequence of operations in one department. The plan is to have the last man in the "chain" do the inspecting. Advantage is frequently taken of the opportunity to pay all operators in the chain only for good work turned out at the end of the chain, the theory being that this compels each man to goad on the other fellow to increase his output as well as to turn out accurate work. When this is done it seems to me it becomes a "chain-gang" plan. It has the merit of preventing additional labor on defective work, but is so conducive to ill-will that it is not used very extensively.

There are other plans of inspection, most of which are variations or combinations of the above. It has been my experience that in every case, their efficiency can be measured by the degree with which they satisfy the five given conditions, namely:—certainty in fixing responsibility, success in preserving good-will, efficiency in delimiting the inspector's authority, surety in making the operator detect defects, and accuracy in providing records of appreciable rejections.

A sane and safe plan of action is impossible unless it involves a sane and safe principle. The principles or conditions I have stated are based upon observations of results obtained in a number of factories, and have been followed with success in devising comprehensive plans of inspection for several large industries. They are applicable to any type of management—military, functional, or otherwise—to any class of manufacture, and to any sized factory. But it will be useless to try to apply them unless it be kept in mind that "Whatever is worth doing at all is worth doing well."

DEFECTIVE AND DANGEROUS FEATURES IN ELEVATOR OPERATION.

By Reginald Pelham Bolton.

It was pointed out in connection with Mr. Bolton's article in our issue for December last, that the question of safety in elevator travel is one which touches closely and personally a very large fraction of the population. It is matter of strong individual interest to almost every occupant of a modern American office building, many times every day. Mr. Bolton has already shown that there are really no satisfactory provisions now in force for such supervision or inspection as should insure safety, in the matter of mechanical construction and maintenance. He now points out some common dangers of operation. We believe it will be a valuable service to educate and stimulate public opinion to co-operate with the present officials and the large manufacturers, in providing for a better and a safer order of things than now prevails.—THE EDITORS.

THE subject of elevators is one of vital importance to all owners and occupants of lofty buildings: especially is this the case in those devoted to offices, where the nature of the service to be provided is exacting, and one requirement is a regularity of operation which has come to be known as "schedule service." Such a service is nearly related to the conditions of railroad traffic, and demands a study as to its details, which is rarely bestowed upon it.

The proportioning of elevators, as to number, speed, and size of cars, is a matter involving considerable technical knowledge. The study, however, is usually omitted by the architects of new buildings in favor of the adoption of the practice of some other buildings, often quite faulty in this respect, or in favor of the opinions and recommendation of manufacturers or contractors. More often still, the main feature is decided by subservience to some architectural detail, or a desired arrangement of the interior or of the steel framing, whereby the most extraordinary arrangements as to numbers, location, and shape of cars result.

A rough idea has prevailed of a relation between the rentable area of the building and the number of cars provided, which, however, does not involve the all important element of height, or distance of the rentable area from the starting point; and inasmuch as the useful effect of a car diminishes in proportion to its travel, the relation of the number of cars to the number of superimposed floors is all important. In many buildings, the rough method of operating about one-half of the cars to a certain height, and the remainder to the

floors above that level, has prevailed, with confusing results; and in others, the very objectionable features have been adopted of overspeeding the cars, and of attempting to make up for shortage in numbers by increase of size, both being features which, while involving unnecessary cost of operation, do not afford desirable service and even introduce elements of actual danger by excessive speed, haste in operating doors, and by the crowding of the public in and out of the cars.

The development of reliable signal systems has added considerably to the capacity of elevator traffic, and has proven of much value in eking out a shortage of cars in some buildings and in securing more care by operators. The public has become largely educated to their use, and has thereby greatly facilitated the prompt stoppage of cars, especially on down runs. The signals inside the car are of two forms, audible and visible. The former has been found to be confusing, and the latter is often so placed as to be invisible to the operator, if his attention be directed, as his duty properly demands, towards the doors. The result is that many operators are allowed to neglect the signals habitually, a practice which superintendents should examine into and correct. A direct saving in the coal or power bill may thus be effected. If the signal be found to be badly placed, it should be rearranged so as to come into the vision of the operator while he is standing in his proper position and his gaze is directed to the door.

Cars are frequently provided with a closed panel in front of the operator, which is an undesirable and unnecessary feature, limiting the vision of the man to a side view out of the door. In some expensive cars recently erected, a large bevel-edged mirror has been placed in front of the operator, which must perplex his vision very much, and on account of the glass the signal is placed in the corner, where he cannot see it except by turning away from the door. The result is defective service, constant over-running and returns to landings, with consequent expense for power.

The doors are in many cases altogether too heavy, generally on account of some architectural design, or some conformity with interior decorations. If they are lighter, better and more prompt work can be done by the operator with less danger to the passenger.

If fire risks were properly considered, and the smoke danger provided for, all shaft door panels would be filled in with wire glass. This should be a complete closure, and not (as is the case in the Trinity Building) with ornamental openings in the lower parts of the doors, thus defeating the object of the fire and smoke screen.

The excessive weight of doors has led to the development of automatic apparatus for opening and closing them, which, while very effective in relieving the operator of much muscular work, introduces an additional complication of mechanical appliances. It is certainly an absurdity to provide doors, as was the case in the Manhattan Life Building, so heavy that no man could be found strong enough to operate them, and then to provide machinery to do the work. The use of ball-bearing devices has reduced the friction of door opening considerably, and greater security is thereby added to the door support, a matter to which little care or detail consideration is devoted.

The foregoing auxiliaries are nearly always arranged inside the shaft way, and on that face against which the open side of the car gives. These projections, and others formed of coamings, or extensions of the landing treads, for the purpose of making up for lack of alignment in the face of the shaft, are sources of danger to passengers standing at the front of the car. For their protection, the New York Department of Buildings requires folding gates in the car, but these are very seldom used. A fatal accident, resulting from the entanglement of a passenger in such projections, has brought about the use of these folding gates in the express cars of that particular structure, but in the way cars of the same building they are in disuse. As constructed, they are, no doubt, entirely too clumsy for rapid use, but a demand for a suitable light-running protection would soon produce a manageable form of screen. Operators should be compelled to use them, clumsy as they are, in all express runs; and in all department stores and elevators used by the general public.

Solid metallic foot-treads are a source of danger to passengers, and should be permitted to be of a safety non-slipping character only. Many buildings have slippery tile landings—a most undesirable feature for passengers. Rubber mats have in some cases been laid across the sills, but these are unstable, and such floor surfaces should be prohibited.

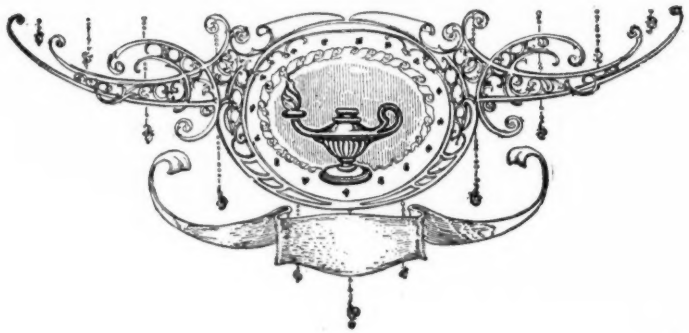
The arrangement of operating levers in many cars is defective, and has been the cause of accident. Their position, when the car is at rest and power is cut off, should be such that the operator's hand need not be removed, while with the other hand he is controlling the door.

Door catches, or latches, are of many varieties, some being very ineffective, and unnecessarily small, making it difficult for the operator to reach them promptly. Many are placed at the extreme edge of the door, away from the operator, when they could as well

be located nearer to him. The most handy form for rapid operators is the vertical rod on the back of the door, placed close to the operator's hand. The effect of this form in facilitating rapid door service is marked, but it should not (as is the case in several buildings) be extended the full height of the door, as this permits reckless operators to commence opening the door before reaching the floor, and inversely, to start the car and take chances on closing it as the car passes the extreme end of the rod.

This feature leads to a remark upon another reckless habit of many car operators—that of neglecting to use their control levers at the end of the runs, depending upon the automatics at top and bottom. The practice is a growing one, and is fraught with danger, especially on the down-runs, and to plunger machines, on the up-runs. Operators have been observed frequently to start an express car down and then entirely let go of the control lever. The best automatic cut-off device is subject to possible disarrangement, by the sliding of stops, jumping of rope, or other slight mishap, and operators should be disciplined into the proper use of the control at both end landings.

Correction of some of these features, and attention to others, with a better training of operators, will go far to improve elevator service in very many buildings, and while reducing its cost, will provide greater security from injury to passengers—a matter in which owners and insurance companies are as interested as the public.



MACHINE-SHOP IDEALS IN FOUNDRY OPERATION.

By W. W. McCarter.

IT is not intended in this discussion to criticise or to reflect in the least upon a man who, in the capacity of superintendent, foreman, or even manager, has the interest of his company at heart, and who manifests an intense desire to subserve the company's interests in a way altogether creditable to himself. It is a duty incumbent upon one's position and personal character to take care of the company's interest by the exercise of diligence in matters appertaining to his sphere or position.

Considered from a human standpoint, there are two classes of men filling important positions with whom we come in contact. They are *good* and *bad*. There are no "indifferent" among them. The man who has shown thoughtfulness in every way applicable to his immediate surroundings and the interest of his employers, and has made good every confidence reposed in him for the betterment of his company's interests, is, in my opinion, eminently worthy of being classed "good." To endeavor to define the other kind of man would only be wasting space, for he is not likely to be either touched or taught by what may be said counter to his ideas. Incidentally, however, I would say that the over-wise machine-shop foreman is indeed the source of inspiration for this article.

With the foundry which is an adjunct to the machine shop, I might manifest my acquaintance by explaining that my experience covers more than a quarter of a century, and that I have come into contact with the autocratic Mogul referred to above some years ago. It is not necessary to go into detail and thereby become generally disagreeable, but suffice it to say that one who is not at all familiar with foundry work should maintain sufficient discretion to refrain from volunteering his services as a dispenser of knowledge, particularly in an aggressive manner, to one who has a rational idea of what may be accomplished in a department in which he has been virtually reared.

False economy in foundry practice is in keeping with the primitive state in which it is often left, even in modern establishments. I once accepted charge of the foundry of a concern manufacturing power-transmission machinery. Of this speciality only was the concern at all solicitous, it being their desire and intention to adhere strictly to their own line of work and let general jobbing work out altogether. Consequently, the foundry (which had previously been a "necessary evil") was philosophically nurtured into a meritorious necessity.

All standard patterns of which large numbers of castings were required were mounted on machines suitable to their class; other patterns were "odd-sided" or follow-boarded, and still others were supplied with match plates. Metal sheave-wheel patterns of the "old-school" type were sweated together and a core print supplied and neat, cast core-boxes and lifting rings for these green-sand sheave cores were made. Wood patterns for sheaves were accordingly made solid. Green-sand core arbors were made, and subsequently green-sand cores supplanted many of the dry-sand cores of former days.

Clumsy wooden flasks were done away with, and neat hinged cast flasks were supplied in their stead for light floor work. Work which was made in the pit and dried in the pit likewise received its share of attention along the lines of advancement. A great deal of the loam class was transformed into dry sand, and the dry-sand work in its trend of progress was put into the oven in the evening, and brought out the following morning and made ready to receive the metal.

An analytical survey on the part of foundrymen will show that the few things mentioned are worthy of attention only in such cases as arise under similar circumstances—viz., a change from the old to the new.

It would not be well to omit the practice followed in the grading or mixing of metal charged into the cupola for certain classes of work. I shall take it for granted that every foundry superintendent knows that silicon reduces the strength of cast iron, that sulphur, graphitic carbon and phosphorus do the same, and that manganese and combined carbon increase the strength. I also take it for granted that every foundry superintendent is not called to the painful task of comprehending the whole process of separating iron from other matters in the ore, refining and parting them, but only preparing for use that which he has at his disposal with a knowledge that the value of the work is largely due to the facility with which the casting can be

machined, the prime object being to produce the maximum of strength where it is particularly demanded. There is a prevailing idea among a certain class of machine men that "iron is iron." It probably may be so, but not altogether wise to adopt their nomenclature and stop at that. The expectation that it will be practicable to make light castings that are to be machined from metal charged into the cupola for heavy work, is nothing short of absurd. Iron suitable to make a heavy casting close, strong, and reliable, is unfit for light machine work. For instance, a rubbing bed for marble, 5½ to 6 inches thick and 12 to 15 feet in diameter, weighing 9½ to 12 tons, in which soundness and uniform grain are demanded, must necessarily be produced of metal low in silicon and phosphorus and may have a higher content of sulphur and manganese than would be permissible in light castings.

Silicon is regarded as a softening agent, by reason of its property of releasing graphitic carbon in the cooling of the metal when in a liquid state and thus lowering the combined carbon. A high content of phosphorus is liable to produce that disagreeable effect of cold-shortness which often presents itself just under the scale; especially does this occur in castings of large area. If the class of work be only light castings, such as pulleys, sheaves, gears, sprockets, etc., irons which are high in silicon and phosphorus and low in sulphur and manganese should be employed. These elements induce the qualities of softness, fluidity, elasticity, and strength for almost any ordinary purpose.

For locomotive cylinders, it is necessary that a close, hard, clean casting be produced, keeping in mind the fact that it must be bored out, it must be planed and drilled—in fact, there is a good deal of machine work to be done on it—and not only *it*, but a plurality of them. A variety of metal is not wanted; on the contrary, a standard uniform high grade of iron is not only required but is absolutely demanded. For this particular line (or speciality as I would prefer to term it)—steam cylinders—it has been my experience that the gates and risers from the two very dissimilar irons provide a very important factor in securing the desired quality of metal, the gates and risers of the light class predominating in a ratio of two to one over those of the heavy class. For example:—say we have 600 pounds of the light class, and 300 pounds of the heavy class; to this 900 pounds of scrap of known qualities, is added 600 pounds of light class pig, high in silicon and phosphorus and low in sulphur and manganese. We thus make up our charges of 1,500 pounds. This

size of charge is particularly adapted to small cupolas from 28 to 36 inches in diameter using a blast pressure from 8 to 12 ounces, the alternate charges of coke fuel ranging anywhere from 60 to 120 pounds, varying of course with local conditions.

I have known of instances when the matter of taking off a heat amounted to the old saying of "burning all coke and melting no iron." Again, I have known of instances where not enough coke was used and as a consequence dull iron and imperfect castings were the result. In melting, proper care should be exercised in charging the cupola; this should be done under the personal direction of the foreman. In case of his absence from the scaffold at the proper time, he should designate some one, other than the cupola man, or melter, who is familiar with his method of charging special metal. Even in this I have known failures to result on account of oversight, or perhaps carelessness, in charging the first metal upon an abnormally low bed of fuel. In this case the metal is extremely foreign to the quality desired, inasmuch as the blast pressure delivered is the same as that under normal conditions, and with the low bed of fuel is exceedingly high with reference to the absorption of matter from the fuel, the result being the oxidation of the chemical elements of the iron by reason of the excessive blast pressure.

I can recall to memory the time when the grading of iron was determined exclusively by fracture, a test still relied upon in some localities at present. It is still clear in my memory that many castings of good appearance were rejected after they had been chucked and an attempt made to take a cut over them. I have known every pulley in a single heat to go to the scrap pile immediately after they were rapped out of the sand. I shall never forget the four open sand plates which were intended for use in the construction of a reservoir for the purpose of pouring a large casting. These plates were 5 feet by 7 feet, and 1¼ inches thick, reinforced by a rib 1 inch by 1½ inch at right angles. These plates were rapped out as castings usually are, the next morning, having been cast the previous evening. They were swung longitudinally along the side of the shop and leaned against the wall. After the lapse of about two hours, each of the four plates burst in half, all within one minute, with a report like that of a pistol. This was of course considered a phenomenon, and perhaps was, especially the rapid succession in which the plates burst.

It may be a little distasteful to a foundry foreman to be thus reminded of his times of adversity along these lines; but if he had been on the scaffold at the proper time, or if his instructions (with refer-

ence to charging the furnace) had been properly executed, the phenomenal trimmings might have been omitted, along with a barrel full of those adjectives which explode like firecrackers.

The discussion of conditions embracing many psychological elements often results in nothing more than an expression of the writer's personal viewpoints, and the reader finds himself flimflammed into swallowing a sugar-coated moral pill when he really wished to be amused. If we should look into certain phenomena of the machine shop which occasionally present themselves to the observation of those closely connected with the foundry, perhaps it would be discovered that they are not altogether the outgrowth of dishonesty nor of insincerity. I remember something about a cylinder for an automatic engine, and the first casting from a new pattern. A few days after this casting was made it was carried into the shop and bored out, flanges faced off, valve seat faced, and finally finished up and delivered to the erecting department. Other machine work on this particular engine had preceded and was in waiting for the cylinder. On its delivery it was discovered that in some way not well explained the machine work was all wrong. To use the common expression, the cylinder was "killed."

Nevertheless, with all these occasional contingencies, the standardization of machine-shop work is far in advance of that of the foundry. It is a very common thing to note the well appointed tool room in every establishment of any degree of importance, with its splendid array of jigs, pneumatic tools, etc., but if we turn to the foundry department of the same concern, we are too often unable to distinguish any very marked signs of progress. An eminent writer on foundry practice has said that "there is a growing demand for foundry standards." He further asserts that "we shall undoubtedly see the day when all the designs of the drafting office of an industrial establishment will go for revision to its foundry superintendent, in order to standardize the non-essential elements therein and create less labor in producing the castings."

This without doubt suggests the initial step toward the banishment of primordialism in the foundry, and until this very sound purpose shall have been recognized and applied, foundry work and foundry standards will remain very much the same in future as they have in the past.

There are a great number of standard patterns of which hundreds, or perhaps thousands, of castings have been made, and they are still being repaired and used in the same old way every season. Not very

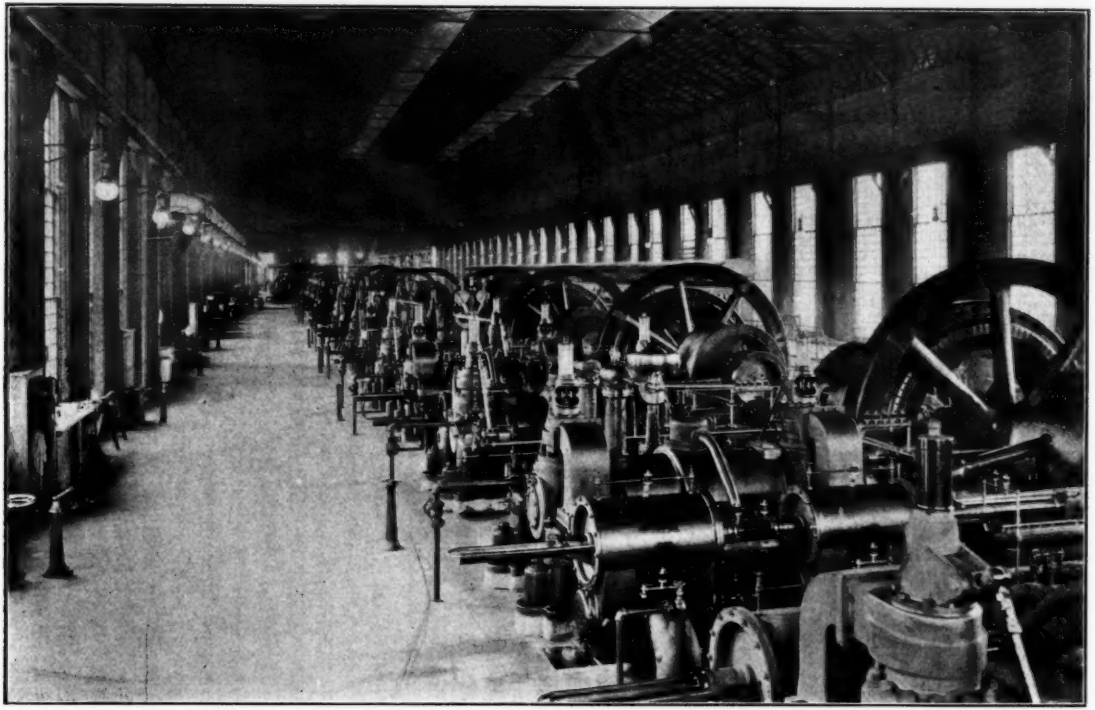
long ago, a company with which I was identified received an order from a well-known machine-tool company for a large number of pulleys, the patterns being furnished by the buyers. Among the lot of patterns were several sizes with extra heavy face. Every pulley pattern furnished was as rigid as a casting itself, the hub and arms being made fast to the face. This style of pulley-pattern making would perhaps suit any one outside of the foundry, but when castings are expected to be produced it is quite a different proposition. They should have been made either in halves, or the arms should have been separate from the rim (or face); or, the cope half of the arms should have been doweled to the drag half. In either of the latter two instances the cope part of the hub should have been doweled on, simply to facilitate the imperative matter of patching up, in cases of this kind. These patterns had been used before, at another foundry. Their appearance clearly demonstrated that fact, because the trowel marks of the moulder were visible, showing that each successive joint had been made with the trowel, and that no standard had been observed with reference to ramming up the drag or making the joint. If a correct follow board or odd side had been used, no trowel marks would have appeared. By this simple observance of a standard, making the joint simultaneously with the ramming up of the drag, two-thirds more castings could have been produced per diem with a corresponding amount of labor, to say nothing of the general appearance of the work. The style of pulley patterns referred to is limited exclusively to floor work; they could not be mounted on machines without dismembering the arms from the rim (or face). A new set of half-arm patterns would have to be made, in the event a set belonging to the required inside diameter were not among the standard machine paraphernalia. There are other reasons peculiar to foundry practice which limit this style of patterns strictly to floor work, the greatest being that of "primordialism."

If from the foregoing the fact may be deduced that other patterns supplied to the foundry stand in the same position as those above mentioned—so far, that is, as concerns the facility with which they can be used *as patterns*—then it is pertinent to suggest the great practical importance of congeniality between the foreman pattern maker and the foreman of the foundry. Constant accord between them in the exchange of ideas concerning the parting of patterns, the doweling on of lugs, strips, core prints, etc.,—especially in the case of work which is out of the ordinary—will prove remunerative in no small degree to the company happy enough to secure the har-

mony of relation. It is through this channel that many new jobs have reached a successful termination.

The subject of permanent moulds is receiving a great deal of attention in some localities. We have just recently removed the third casting of 9½ tons weight each, and expect to be successful in casting an equal number (if not more) in the same mould. The permanency of a mould of either loam or dry sand is commensurate and associated with its construction, with reference to its vent conduits, porosity, and cohesive qualities. The latter two important features are governed by the percentage of sharp sand and clay respectively employed in the construction of the mould, and their qualities are capable of being resuscitated after the removal of each casting by the application of a solution of which linseed oil and litharge are the base, heated to about 190° F. One "swabbing" only, of this solution is necessary; it is rapidly absorbed by the surface of the loam, and in dry sand, it will penetrate to a depth of 2½ to 3 inches.

Glancing into the machine shop we may perhaps be reminded that it has more than once occurred that the machinist who has the drawing and the job before him is at a loss to find stock enough to true up just as the stock allowance should; but he manages to "throw it" a little, and get under the scale at the point of deficiency, and the job is completed in the time allowance and in accordance with the drawing. From such evidence we would judge that as an apprentice he had enjoyed competent instruction. On general principles the moulder can not be measured with the same rule, because it is not a general custom, nor has it ever been, for an apprentice at the moulder's trade to have drawings of how to ram up a mould, or to have any very definite physical example fully explained during his term of apprenticeship. Within the past several months I have found that the application of diagraphical explanations associated with practical demonstration has exceeded even large expectations. I feel sure that if every apprentice were accorded this method of instruction the foundry would soon be reorganized and co-ordinated with the machine shop, and the conditions of an expanding competitive business would be met with a comparatively small degree of exertion and outlay of capital. With the banishment of "primordialism" from the foundry an enterprise surrounded by modern industrial and economic conditions would thus resolve itself.



THE LACKAWANNA STEEL COMPANY'S ELECTRIC POWER HOUSE, GAS-ENGINE DRIVEN.

Eight 1,000-horse-power Koerting gas engines. Four alternating-current and four direct-current generating units. Photograph by courtesy of S. B. Sheldon, Gen. Supt.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

By A. E. Dixon.

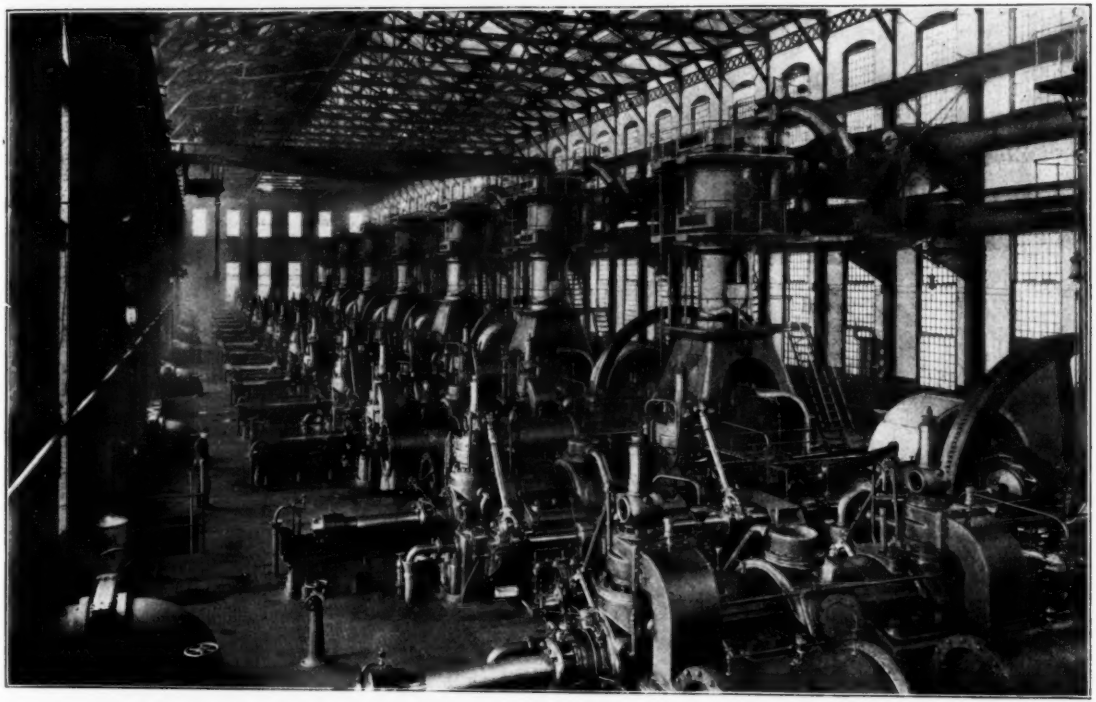
VII. GAS ENGINES AND GAS GENERATORS.

Preceding sections of Mr. Dixon's discussion have covered the location of plant, the storage of fuel, boilers and chimneys, natural and mechanical draft, water supply, and main and auxiliary machinery. On account of the inadequate progress (as yet) in the introduction of large gas engines for general power purposes, some of the illustrations in the present paper are drawn from smaller installations than those the discussion has primarily in view. The field of the internal-combustion engine is one of the most interesting and important in modern mechanical practice. —THE EDITORS.

ON account of its high thermal economy, the gas engine presents many interesting possibilities. In large sizes, suitable for the electric generating plant, this machine has only been on the market for the last ten years; it is possibly due to the fact that those most interested confined their efforts almost entirely to iron works where blast-furnace gas was available, and were not actively identified with the electrical industry, that outside of blast-furnace plants comparatively few machines have been installed for driving dynamos, though nearly 60 per cent of those installed in such plants are used for the generation of electricity, a number of them driving alternators in parallel.

In view of the fuel conditions in Germany it is but natural that this type of prime mover has attained its most extensive development in that country, though the largest machines, or the highest powered single units, are in use in the United States, operating on and pumping natural gas; larger units are under construction in America for driving electrical generators; these latter machines are to be operated on carburetted water gas.

The earliest examples of the large gas engine, those built by the Cockerill works, were expected to operate upon blast-furnace gas taken direct from the furnace. This gas contains a large quantity of dust and caused considerable wear on the engine. The use of unwashed gas was not approved in some quarters; but at that time there was no practicable washer capable of handling in an economical manner the enormous quantity of gas issuing from a blast furnace. As the result of efforts to improve this condition, a purifying system has



GAS-DRIVEN BLOWING ENGINES, LATEST BLOWING HOUSE OF THE LACKAWANNA STEEL CO.

Eight 2,000-horse-power Koerting gas engines. Blowing tubs by the Southwark Foundry & Machine Co. Photograph by courtesy of S. B. Sheldon, Gen. Supt.

been developed consisting of dry dust catchers, tower scrubbers, and centrifugal purifiers, the gas being finally dried in tanks or holders, to get rid of the moisture absorbed in passing through the scrubbers and centrifugal purifiers.

Besides those running on blast-furnace gas, there are gas motors in operation using water gas (uncarburetted), coke-oven gas, bench gas, and carburetted water gas, and in addition the large number using producer gas. In some cases gas running as high as 52.50 per cent in hydrogen is used in four-cycle engines and gives but little trouble in operation, despite the fact that gas of this character is usually considered unsuitable for gas-engine work; the pre-ignition troubles with such gases are due more to deficient cylinder-cooling arrangements than to any other defect in design.

Pre-ignition has been largely laid to the hydrogen content of the gas used, owing to the well-known fact that hydrogen gas has, by itself, a speed of burning six times as rapid as that of carbon-monoxide gas, which on its face makes hydrogen a very plausible scapegoat for the trouble. It is, however, well-known that carbonaceous and sooty deposits often occur in gas-engine cylinders; when sooty deposits occur they are liable to inflame from time to time and may easily carry over heat enough to ignite a following charge prematurely. The irregularity with which pre-ignition troubles occur would seem to indicate some cause similar to that above mentioned, as these sooty deposits would be consumed and then re-form. A high hydrogen content often occurs with gases which have a sooty flame.

From the following it will be seen that there is a variety of methods by which the gas for power purposes may be generated.

Producer gas; air blown, using anthracite coal.
steam blown, using anthracite coal.
steam blown, using bituminous coal.
steam blown, using coke.

By destructive distillation of coal;
in retorts (bench gas).
in coke ovens.

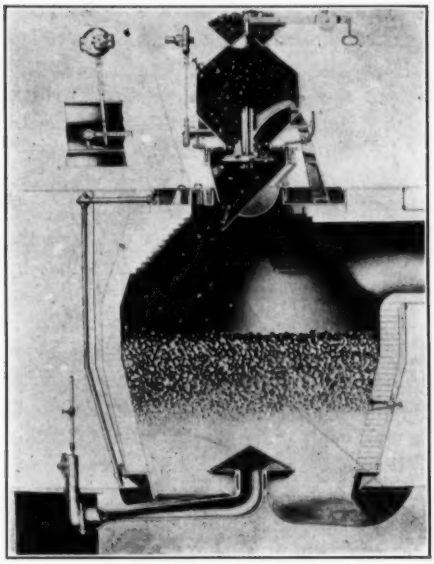
Water gas; { blue or carburetted.
using coke or anthracite coal as fuel.

Oil gas; a number of processes are in use.

Natural gas.

Waste gases from smelting furnaces, more particularly those for smelting iron ore.

In all of these gas-generating processes it is necessary to wash or purify the gas before passing it to the engine, in order to get rid of dust; and should the producer or distilling plant be of sufficient size to warrant it, by-product recovery can be introduced; concerning this more will be said later.

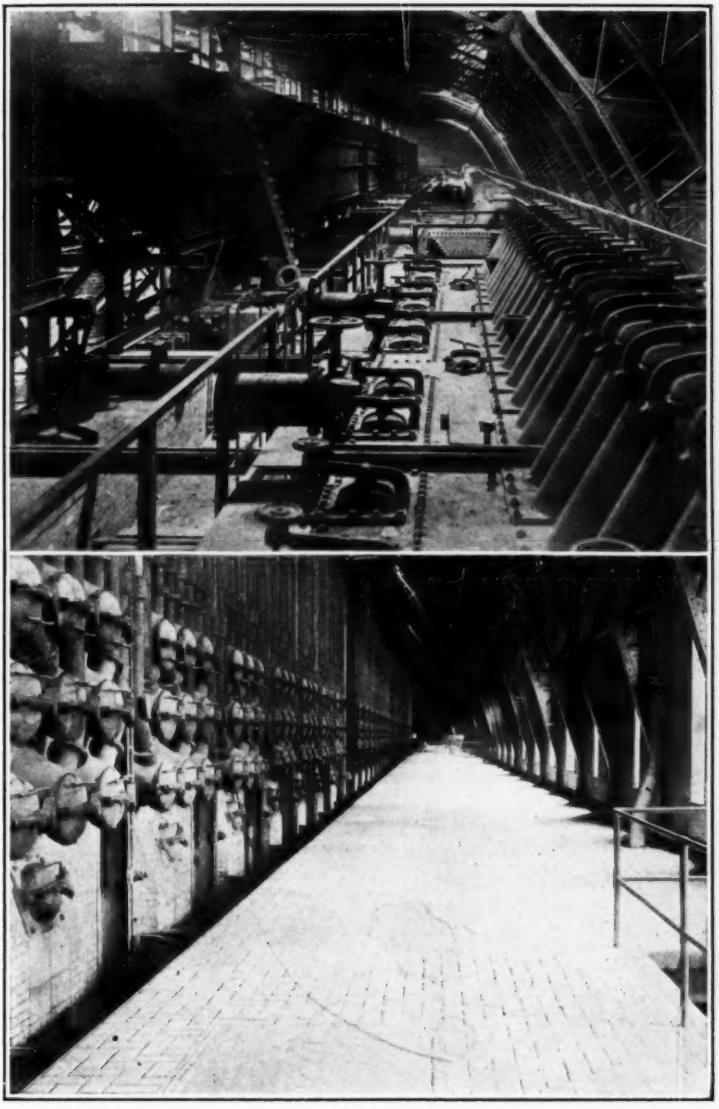


CROSS SECTION OF MORGAN CONTINUOUS GAS PRODUCER.

Morgan Construction Co., Worcester, Mass.

Air-blown or suction gas producers have not proved very successful with bituminous coal, but a number of plants are in service and give excellent results with the cheaper grades of anthracite; the trouble with bituminous coal in such producers arises largely from its clinker-forming and caking capacity. Steam-blown producers have been in successful use for years; in most cases the steam is derived from some convenient boiler plant, but some producers have been designed which generate their own steam, at a low pressure, in a water jacket surrounding the combustion chamber; these producers have been used in gasifying a wide variety of fuels, ranging from peat and wood to most kinds of coals and lignites. The Mond gas process uses bituminous slack and recovers ammonia and a portion of the tar.

It is something over a century since William Murdoch first devised the apparatus for distilling coal, and since then many improvements of detail have been added, and the size of the retorts has been increased so that today charges of 400 to 800 pounds of coal are carbonized per retort in from 4 to 6 hours and from 3 to 11 retorts are set in each bench; this method of distillation gives a gas which is widely used for domestic purposes and incidentally for running many small gas engines; the coke produced is however



A MODERN RETORT GAS WORKS. PART OF THE GAS PLANT, ASTORIA LIGHT, HEAT & POWER CO.

Capacity 25,000,000 cu. ft. a day. The upper view shows the top of the inclined retorts, the hydraulic mains, and dip pipes on the right; the coal-storage bins are on the left. The lower view shows the discharge or coke floor. The hot coke conveyor runs on the left. Installed by Bartlett, Hayward & Co., Baltimore.

BATTERY OF SIXTEEN MORGAN CONTINUOUS GAS PRODUCERS, LACKAWANNA STEEL CO., BUFFALO, N. Y.

The view shows the charging floor, with automatic feeds and traveling crane carrying coal hopper and weighing scale. Morgan Construction Co.

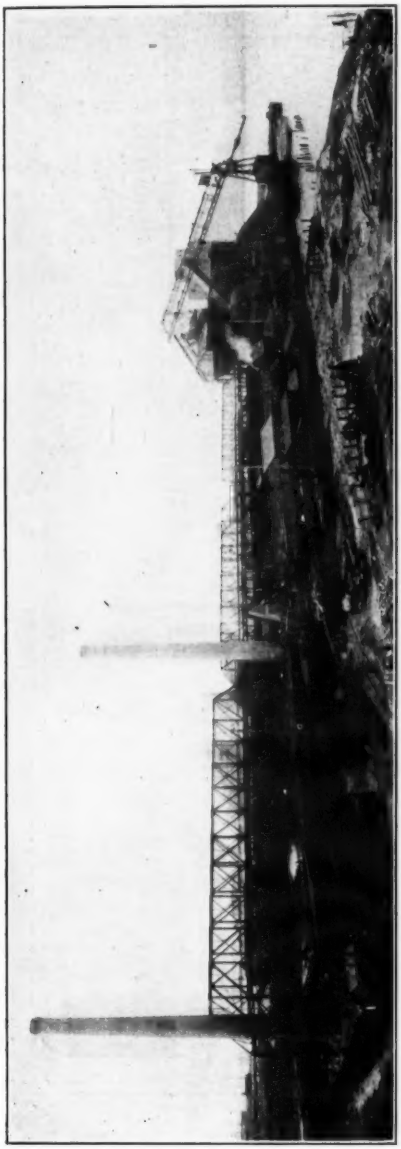
WILE GAS PRODUCER, INSTALLED IN A. H. NILSON MACHINE SHOP, BRIDGEPORT, CONN.

The producer is of 60 horse power, but is operating under a 20-horse-power load; it uses 225 lbs. coal per day of 10 hours and requires but ½ hour attention from a shop laborer. Wile Power Gas Co., Rochester, N. Y.

spongy, and while suitable for domestic fuel or burning under boilers it cannot be used for metallurgical purposes. In a great many localities the public gas supply is a mixture of coal and carburetted water gas. In the manufacture of coal gas, either in retorts or in by-product coke ovens, a number of by-products are secured in the

SEMET-SOLVAY BY-PRODUCT COKE OVENS AT DUNBAR, PA.

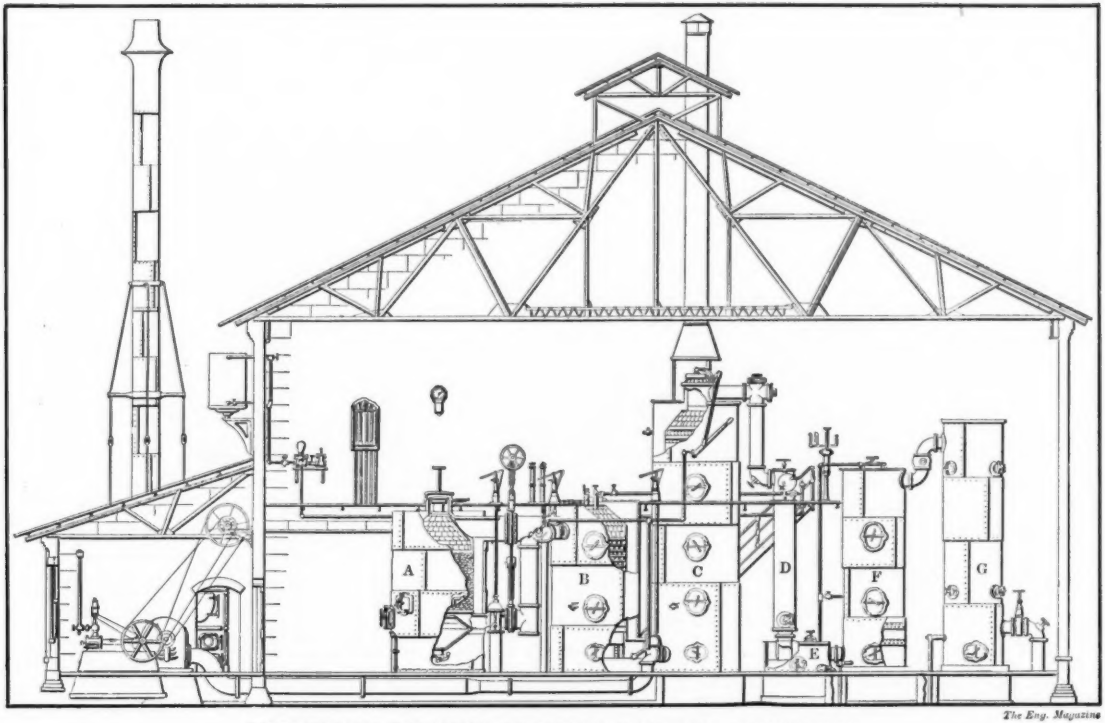
110 ovens. The Solvay Process Co.



CAMDEN PLANT, SOUTH JERSEY GAS, ELECTRIC & TRACTION CO., 150 UNITED-OTTO BY-PRODUCT COKE OVENS.
The gas is used for a gas engine generating electricity at the plant, and is also distributed over a wide area for general purposes, including power.

process of purification—tar, from which a large number of products are secured (notably over six hundred different coal-tar colors are in use, and a number of others are too expensive to extract) and gas-liquor, from which the ammonia compounds and sometimes cyanogen are secured. In addition there are products of value in the spent purifying materials.

The by-product coke oven is practically an enlarged retort, the charge being from 3,000 to 24,000 pounds of coal; from twelve to sixty ovens are set side by side in a battery and the charge is carbonized in from 8 to 36 hours, the usual time being about 24 hours. The gas produced from these ovens is usually divided into two fractions; the first or richer portion is suited to any purpose for which ordinary bench gas is used, while the second or poorer portion is utilized for heating the ovens. The coke produced is suitable for metallurgical purposes and is largely used in Germany for blast fur-



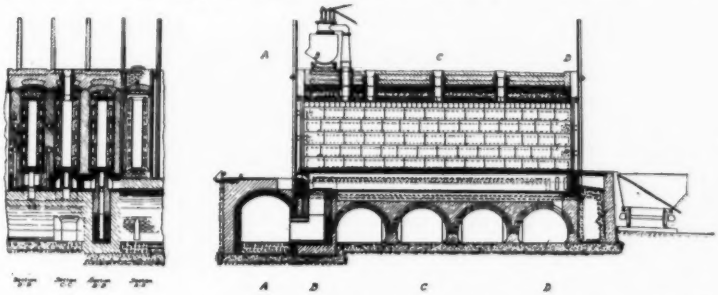
The Eng. Magazine

DIAGRAMMATIC ELEVATION OF TYPICAL WATER-GAS INSTALLATION.

A, water-gas generator; B, carburettor for vaporizing oil; C, superheater for fixing oil gas; D, take-off pipe containing oil heater; E, wash box or water seal F, scrubber G, condenser United Gas Improvement Co., Phila.

naces, and to some extent in other countries. With by-product coke ovens the surplus gas over oven requirements is from 3,000 to 4,500 cubic feet per ton of coal carbonized, and with ordinary gas retorts the production is about 8,000 to 9,000 cubic feet per ton; but in this latter case a portion of the coke produced is used for heating the retorts, while the coke oven uses gas fuel exclusively.

In the operation of plants of the above character the market for the by-products must be considered; at present this is limited, and while constant expansion is taking place, demand and supply are very delicately balanced, particularly in the United States where any large increase in the supply would be liable to upset present values.



LONGITUDINAL AND CROSS SECTIONS OF SEMET-SOLVAY BY-PRODUCT OVENS.
Capacity 7 to 12 tons of coal per day, each. Solvay Process Co.

Water gas is produced by blowing a current of steam through a bed of incandescent fuel, which dissociates the water into its elements; the process is intermittent, the "run" during which gas is made lasting from 2 to 10 minutes and the "blow" during which the fire is worked up to a suitable temperature by an air blast is of similar duration; the time required for a "run" or a "blow" varies in the different processes; some require a short "blow" and give a long "run." For illuminating purposes or for mixing with coal gas, carburetted water gas is used—that is, the gas is enriched by the evaporation of oil, and these vapors are fixed by passing through a superheater. Blue or uncarburetted water gas is used in many manufacturing processes and recent progress in this line has greatly reduced the cost of production and widened its field of usefulness.

Oil gas is produced by the vaporization of mineral oil at high temperatures. It has a high illuminating value and its use is restricted to special purposes, particularly the lighting of railroad cars, for which purpose it is eminently fitted owing to its small loss in illuminating power when subjected to high pressure.

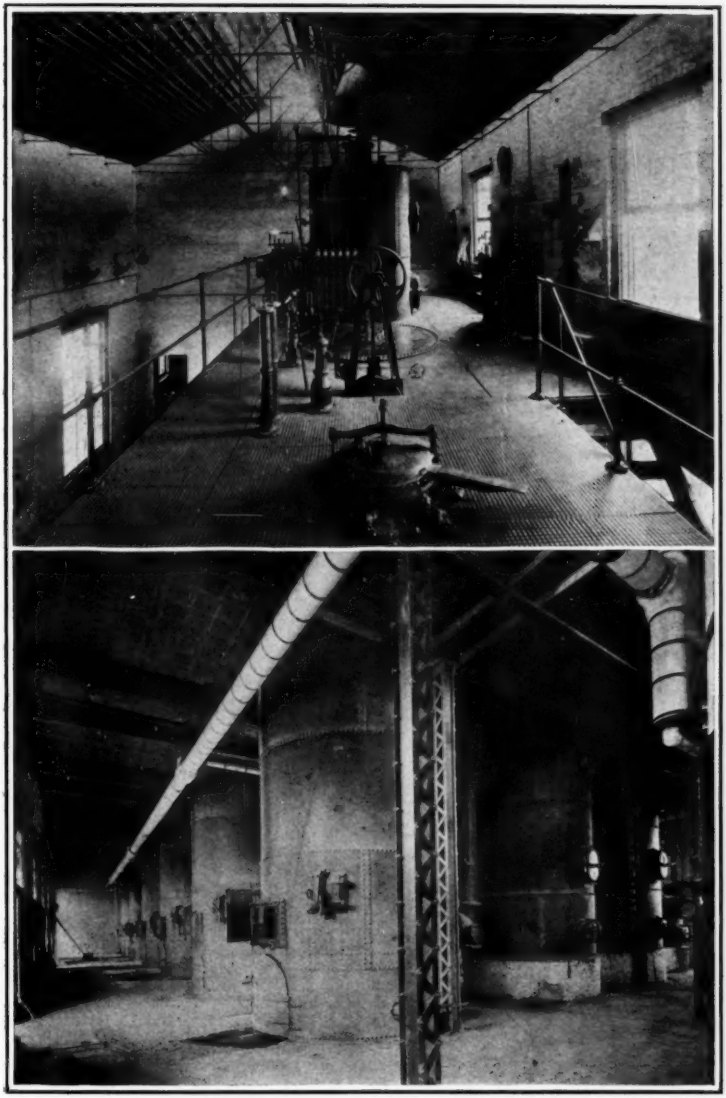
Natural gas is available only in certain localities, but is largely used for fuel purposes and the generation of power.

The following table presents the typical composition of different gases, but particular cases are liable to vary greatly; for instance in producer gas the hydrogen may vary from 1.00 to 25.00 per cent.

TABLE OF VOLUMETRIC COMPOSITION OF GAS FROM VARIOUS PROCESSES.

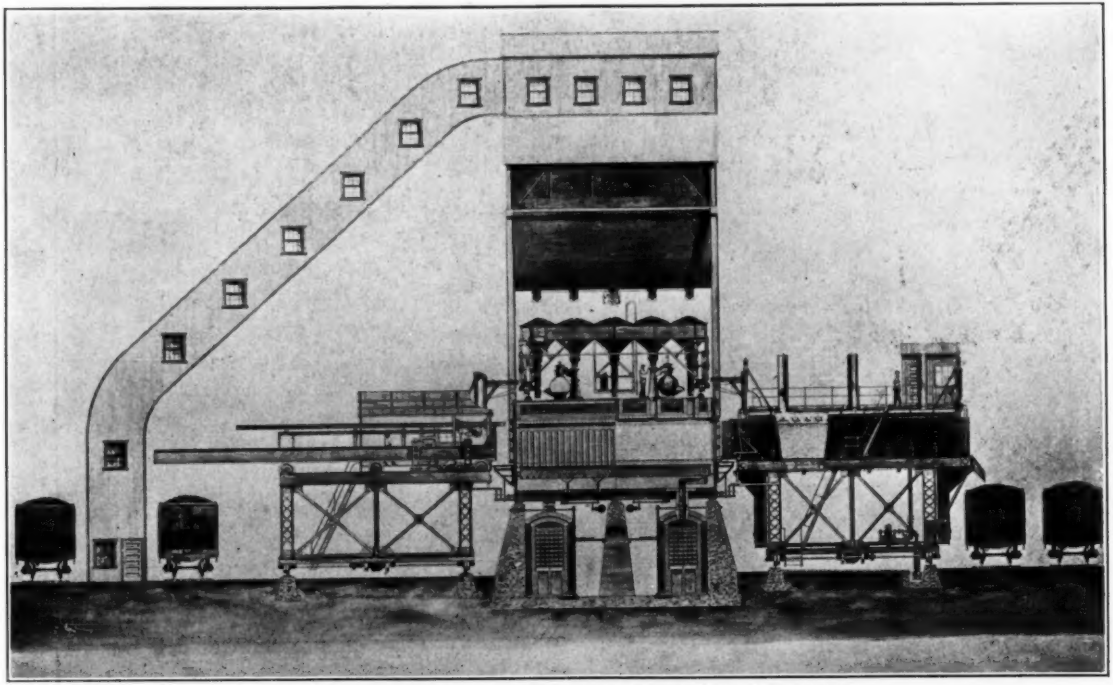
	H	CH_4	Cn Hm	O	CO	CO_2	N	B.h.u. per cu.ft.
Mond, slack...	27.80	2.20			12.20	16.00	41.80	144
" coke.....	25.20	0.40			10.80	16.80	46.80	128
Producer gas...	19.40	9.60		0.60	25.00	4.00	41.40	223
" " ...	9.20	3.10			25.30	3.40	58.20	155
Suct. producer.	0.40	0.70		1.2	26.20	1.80	69.70	100
Blast-furnace ..	1.20				23.50	15.70	59.60	83.5
" " ..	1.80				27.00	9.00	62.80	98
Coal gas Germ..	46.20	34.02	5.09	0.65	8.88	3.01	2.15	642
" " Engl ..	52.22	34.76	3.47	0.49	4.23	0.60	4.23	635
" " Amer..	45.52	37.91	5.91	0.15	5.60	1.07	3.84	720
Coke oven 1....	52.77	31.22	2.57	0.23	7.95	3.27	1.99	
" " 2....	39.80	39.21	5.93	0.57	3.05	1.61	9.83	689
" " 3....	44.30	37.40	5.00	0.10	6.20	2.90	4.10	708
Water gas car..	35.60	17.00	14.60		28.00	3.80	1.00	764
" " " ..	35.88	20.95	15.43	0.01	23.58	0.30	3.85	689
Water gas	51.00	1.00			40.00	4.50	3.50	323
" "	48.00	2.00		0.50	38.00	6.00	5.50	295
Oil gas	3.40	57.70	38.10		0.50			1390
Nat. " Pittsb'g.	14.45	75.16	5.40	1.20	0.30	0.30	2.89	947
" " Muncie .	2.35	92.67	0.25	0.35	0.45	0.25	3.53	1004

Considered in connection with the generation of electrical power, the gas engine offers interesting possibilities in the line of a mixed system of distribution; that is, a central gas plant from which the gas is piped to gas-engine driven sub-stations close to the local centers of distribution. Another scheme contemplates, in large gas-driven stations, the recovery or utilization of the heat at present lost in the exhaust gases and jacket water of the engines. The former idea is perfectly feasible, as coal gas is at present being piped over distances of from ten to forty miles; in this last case it is pumped at a pressure of 10 pounds per square inch and suffers but a very slight loss in candle power; in Ohio natural gas is conveyed nearly two hundred miles from the wells by the use of pumps or compressors. Experience has shown that the transmission losses of such pipe lines are very small, and they would also be much less liable to interruptions than the usual overhead electric-transmission line. With gas-driven sub-stations the main generating plant would be done away with—or more exactly, the electrical equipment would be at the sub-stations and the current would be generated to suit the demands of the locality served, and rotary converters and the transformer sys-



INTERIOR OF TYPICAL WATER-GAS WORKS.

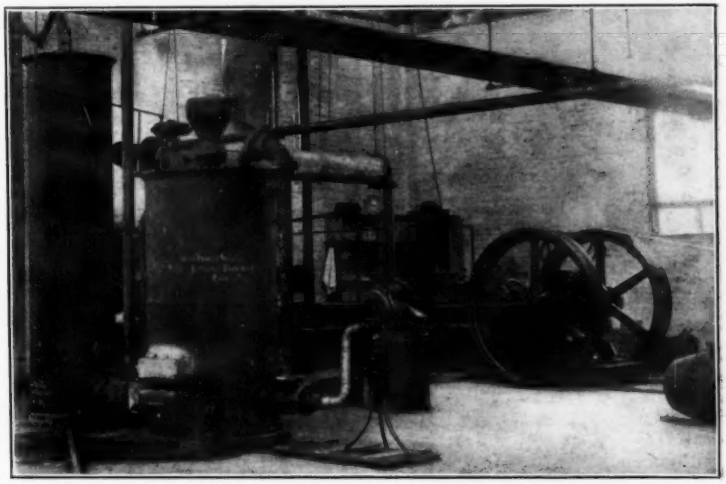
The upper view shows the operating floor of a single set of "U. G. I. Standard" double superheater carburetted water-gas apparatus. The lower is taken below the operating floor and shows six sets.



GENERAL PLAN OF LATEST TYPE UNITED-HOFFMAN COKE OVEN.

United Coke & Gas Co., N. Y.

tem inseparable from high-tension electrical distribution would be avoided, together with the danger due to such methods. This danger is not confined to the immediate vicinity of the high-tension lines but exists over the entire area in which any kind of overhead wiring is permitted; for instance, a laborer was recently electrocuted owing to an accidental connection or cross when supposedly a number of miles from a live wire.

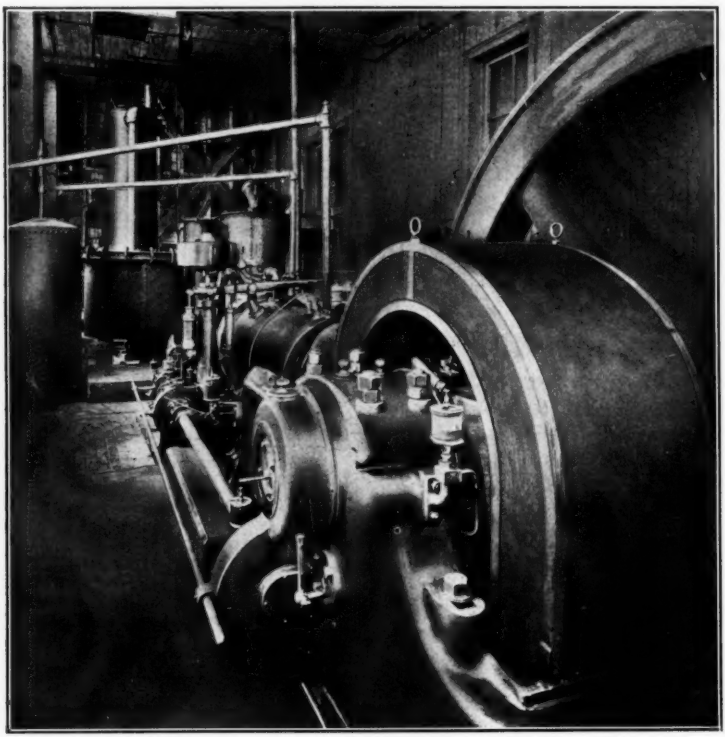


A 60-HORSE-POWER WILE SUCTION GAS PRODUCER AND ENGINE, MORSE IRON WORKS.

Wile Power Gas Co., Rochester, N. Y.

A portion of the economy of a gas-driven plant arises from the fact that the stand-by losses are greatly reduced—in fact, are almost negligible. In addition, a gas producer after standing over 36 hours can be brought "in" in a few minutes; or as economy can be best secured by continuous operation, the gas-making plant can be proportioned to carry the heaviest average load, with a suitable reserve, and the gas stored in holders having sufficient capacity to carry the motors over the heaviest peak. The stand-by losses in steam plants are considerable, particularly in those plants in which a large number of banked boilers are held ready in order to guard against the possibility of any shortage at times of sudden demand. In a certain plant a sudden thunder storm often runs the load up 10,000 kilowatts in a few minutes; to cover such emergencies causes a high stand-by expense.

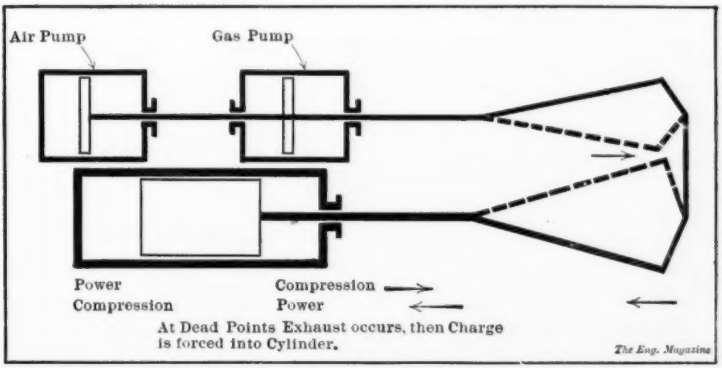
With regard to the utilization of the waste heat from gas engines, it has been suggested that it might be used for the generation of steam to be used in turbines, or perhaps used for the generation of steam which with the waste gases from the engine could be passed through the turbine and exhausted at or slightly below the atmosphere, a simple fan being substituted for the expensive dry vacuum pump required with high-vacuum working. The field is an interesting one.



KOERTING GAS ENGINE, 75-HORSE-POWER, WITH SUCTION PRODUCER, DE LA VERGNE SHOPS.

Drives an electric generator on a coal consumption of 1¼ lb. per kilowatt hour. Dr. La Vergne Machine Co., N. Y.

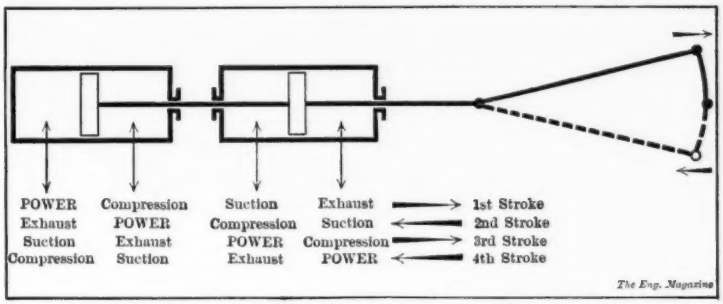
One of the questions often brought up is with regard to the noise produced by gas engines. In practice such plants may be as silent in operation as a steam-driven plant, as the exhaust is easily muffled by the use of water sprayed in the exhaust pipe; a considerable por-



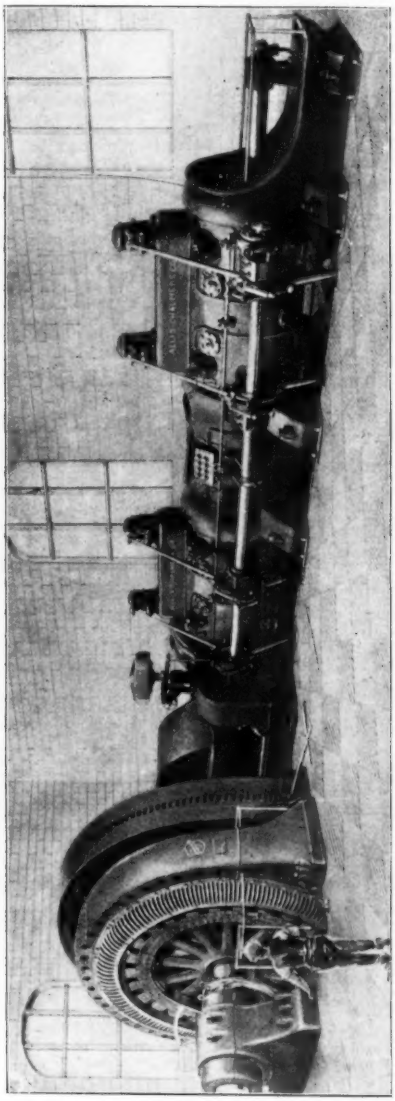
SEQUENCE OF OPERATIONS IN TWO-CYCLE SYSTEM.

tion of this water will be vaporized and in some localities it might be desirable to provide a sort of a chimney to get it out of the way.

The large gas engines on the market are of two types—the two-cycle and the four-cycle—the large units having double-acting cylinders while in small machines the cylinders are single acting. In the two-cycle motor the explosive mixture reaches the cylinder under pressure, while in the four-cycle machine the charge is drawn in below atmospheric pressure; in the former machine there is an explosion at each stroke—that is, in a single-cylinder double-acting engine there are two impulses per revolution; in the four-cycle double-acting motor two cylinders are required to attain the same result, as each end of each cylinder gives only a single impulse at every second stroke. The accompanying diagrams of the cycle of the two types shows this more clearly.



SEQUENCE OF OPERATIONS IN FOUR-CYCLE DOUBLE-ACTING SYSTEM, TANDEM TYPE.

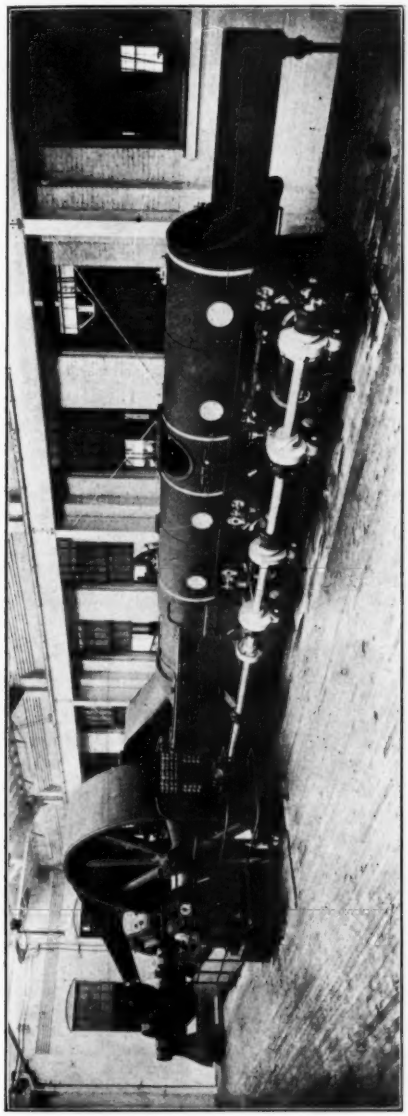


ALLIS-CHALMERS GAS ENGINE DIRECT-CONNECTED TO GENERATOR.
Built in sizes ranging from 300 to 2,000 kilowatts, almost all of the units so far ordered being of the larger size.

The two-cycle motor is not so well suited for high-speed work, owing to the fact that at high speeds the number of explosions is increased and there is difficulty in keeping the cylinders sufficiently cool to avoid all danger of premature ignition; this is particularly the case when gases of high calorific value are used; in addition the methods of governing this motor have not, as a rule, been able to insure the speed regularity obtainable with the four-cycle engine. For the above reasons the two-cycle machine has not been found as suitable for the driving of electrical generators as the four-cycle motor.

The four-cycle gas engine is well suited for direct connection to electrical generators and a large number of them are in use for this purpose. They can be built to govern within 1/400.

The gas-engine builder has greatly simplified his machines from the early models; the question of accessibility for cleaning and repairs has been well considered, and today the internal-combustion motor



SARGENT DOUBLE-ACTING TANDEM GAS ENGINE, 500-HORSE-POWER, AKRON PLANT OF THE WELLMAN-SEAVER-MORGAN CO.
The engine is of the "complete expansion" type; the volume of gases at release is about 1½ times that at cut-off, giving high efficiency of transformation of heat into work and low exhaust-pressure—not much above atmospheric.

is as reliable as the reciprocating steam engine. In the matter of labor or attendance required the two kinds of motors are on a level. In regard to economy of operation the builders guarantee a brake horse power on from 8,000 to 10,000 British heat units at full load, and from 12,000 to 15,000 British heat units at half load. The gas motor lacks overload capacity when compared with the steam-operated prime mover, but this is due to common practice as much as to anything else. With steam units the habit is to call for a machine of a given nominal capacity capable of operating at 50 per cent overload; that is, the steam unit is rated at 66 per cent of its ultimate capacity. The gas motor is given a rating and can run from 10 to 25 per cent higher; that is, it is rated at from 90 to 80 per cent of its ultimate capacity, and it is usually operated at about 80 per cent of its nominal capacity.

So far as concerns the cost of installation, a gas-

motor plant can be put up cheaper than a steam plant with reciprocating engines, but is more expensive than a steam-turbine plant; while in maintenance and operating expenses it will be much cheaper than either of the other prime movers. The foregoing refers entirely to the requisite plant and structures, but there is another factor to be considered; for equal amounts of power to be generated, the steam-turbine plant occupies less room than a reciprocating-engine plant; a gas-motor plant with its producers can be installed in about the same area as a steam-turbine plant. Notwithstanding the fact that the gas engines occupy a great deal of room, the gas-generating plant with its washers and scrubbers can be arranged very conveniently on a limited area, provided such a course should be necessary.

An interesting application of gas motors is that of the California Gas and Electrical Corporation; a considerable portion of the current distributed by this concern is generated in the mountains and transmitted to San Francisco by aerial lines; the company also has a large gas plant; in order to insure continuity of supply under all conditions and to take care of peak loads, it was decided to install a gas-engine plant. The advantages of this course arise in giving the hydraulic plant in the mountains a practically even load over a large portion of the day; the gas plant must be operated to supply the public and hence is always ready and no additional plant was required on this account; for this reason the expense of a gas-driven electrical plant was much less than for a similar steam-driven plant, and the cost of operation and maintenance should be much lower than would be possible with a steam plant for the reason that everything outside of the engine room has been eliminated; the cost of the gas consumed in operation will naturally include all the expenses of generation. One of the advantages of such a plant installed in connection with an existing gas plant arises from the fact that it is possible to obtain a large electrical output without any increase in the gas plant, provided the gas-holder capacity available is sufficient to enable the operation of the gas plant at its full capacity throughout the 24 hours. Such methods of operation are the most economical in making gas, not only in the cost of labor but in the expense of upkeep. The advantage of the gas engine arises not only, in this cases, from its quick starting ability, but from the fact that when it is shut down there are practically no stand-by losses.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

II. THE PRACTICAL WORKING OF THE COMMITTEE SYSTEM.

By C. U. Carpenter.

It was pointed out in introducing Mr. Carpenter's first article, last month, that his papers are the work of a successful man, written in the very midst of the daily, practical application of his methods, and describing the exact plans and principles by which the results are secured. —THE EDITORS.

CONSIDERATION of methods for "curing industrial inefficiency," or for increasing such efficiency as we may already have in the factory, will be much simplified if we keep in mind the classification of defects given in the last paper. If we get the causes of loss clearly recognized and logically grouped for study, we can easily see what must be done (and what must *not be done*) to change these harmful conditions and to secure the much desired improvement.

This classification of the sources of loss and waste in a manufacturing business was:—

1.—Defects of factory organization—the superintendent, the foremen, the job bosses, and the usual methods of management.

2.—Defects of manufacturing systems and shop methods.

3.—Defects of the sales organization and sales methods, and of executive control over the entire business.

Let us understand fully at the outset that there is no infallible panacea—no ready-made "system" which will fit all cases alike. Methods must be suited to the circumstances of the particular shop or department. The first thought in regard to any plan, indeed, must relate to its adaptability to existing conditions and processes, and to the character and ability of the existing men in the organization. Their sympathetic support *must* be secured, whether the new plans affect methods of organization, systems, or shop processes. The most thorough and effective system in existence will not bring the degree of success that should be attained unless it is supported by superintendent, foremen, and job bosses—and workmen. I happen to know of five cases, of importance because of the size of the concern and the thousands of dollars that were wasted, where this mistake was made and failure resulted.

The new systems all "cut and dried," were figured out carefully "on paper," and new printed forms prepared, the old forms destroyed, and the start made. The men introducing them, desiring to retain the full credit and glory for the innovation, made the mistake of refusing to call in the different members of the organization and trying to secure their support, but instead attempted to *force* their pet plans through. They met with instant though covert opposition. Unexpected obstacles suddenly blocked the way—obstacles not apparent to the investigator, but which lay hidden away amongst existing shop processes and methods that could not be changed, waiting to spring up and prevent the longed for progress—all of this to the delight of the men in the departments, who chuckled to themselves (and to each other) because of trouble arising from some difficulty with which they were thoroughly acquainted, but concerning which they said nothing "because they weren't asked."

In one case in particular where the system required an especially large expenditure, its introduction was apparently successful though accomplished after many a hard wrench and pull. However, this apparent success lasted only so long as the devisers of the plan were on the ground to see that its vital points were not neglected, its essential features not abandoned. But when they left the shop and their pet system to the tender care of the old organization, there began a process of disintegration, imperceptible but effectual. The tendency of the workers to abandon gradually methods with which they possibly were not altogether familiar, and certainly not in sympathy, was practically irresistible. Little by little they slipped back, giving up one idea after another, until the result was a heterogeneous mass of methods, part belonging to the new system, part to the old, the final condition being worse than the first.

Oftentimes lack of knowledge of details leads a manufacturer to entrust the important work of reorganization to those who can talk the loudest and make the greatest show of a little knowledge. So important is this work, however, that it may well claim the closest attention on the part of the manager himself. The "show me" attitude is nowhere so important. If you don't know or understand, stay with the problem until you do. Don't let anyone else decide these important things for you.

The support, the coöperation, of the men forming your organization is, then, essential. To enlist it, they *must* have some part in forming the plans, some share in devising the systems. They must be made to feel that the methods are their own. They must be con-

sulted frequently and thoroughly concerning the difficulties and encouraged to suggest ways of overcoming them. If some comprehensive plan that will *ensure* this result—such, for example, as the committee system—can be worked out and put into effect, the difficulties will quickly disappear and ways and means for overcoming the "unexpected obstacles" will soon be found.

With these fundamental principles clearly in view—(1) that reorganization plans must be adaptable to the conditions of the business, and (2) that they must enlist the coöperation of the personnel—we may lay down three ruling ideas which must govern the manufacturer in introducing new profit-making methods into his factory:—

1.—All plans must be based primarily upon recognition of the human element of the men who are affected. Always keep in mind this: "How would I act were I in the other fellow's place, with his limitations of knowledge and experience, and what plans would be most likely to elicit my support, develop my latent ability and bring out the best that is in me for the support of the company?"

2.—The plans must be developed along the lines of the modern "get-together spirit." The facts must be recognized that, nine times out of ten, the joint advice of five men conversant with a subject is immeasurably superior to any plan developed from one man's brain; that the only possible method of developing a proper shop spirit is through getting the men together; that you can eliminate their distrust and jealousy of each other only by bringing them into close contact one with another, handling them tactfully and showing them they are "not such bad fellows after all," that the spirit of "helping one another for the good of the company" can only be brought forth through the spirit that develops *from* coming together; that the feeling of concerted action on subjects vital to the company's welfare can be cultivated gradually, perhaps, but easily, if the proper attention is paid to it.

3.—Thoroughly developed methods of overseeing and checking up production conditions, both as to volume and costs, are vital. System provides these for the management. The heads of a concern cannot see everything, but they must come "mighty near knowing everything," or at least be in a position to scent danger, locate it and eradicate its cause promptly.

Hence the systems for the factory, sales, and executive divisions must be developed with the idea of providing the heads of a concern with accurate methods of overseeing the entire company; systems which will provide an executive, possibly totally ignorant of factory

or sales processes, with data sufficient to enable him to lay his finger on the "Sticking Point," whether it be excessive costs, overproduction, delayed shipments, or unprofitable sales.

Formation of the Committee System.

And now we come to the initial step—concrete, definite, and simple—by which the human factor is recognized, the spirit of coöperation is fostered, and the idea of order and system is implanted.

It is evident that there is but one way to secure the advice on vexing problems of those best qualified to counsel, and also to stimulate these men to give the company the best that is in them. That is by forming "Standing Committees," to handle matters pertaining to routine production and to solve other important problems such as those relating to progress, invention, and economies in production and promotions.

In each factory the problems relating to the foremen who would naturally form the committees and to the work, vary so as to make any hard and fast rules out of the question. But in ninety-nine cases out of an hundred the factory superintendent, naturally the final authority in all cases, should be the chairman of the most important committees. In the case of large concerns, where the superintendent would naturally have several assistants, these may be the heads of the less important committees, though in many cases the work of the committees renders the assistant unnecessary. The superintendent himself should in all cases, however, be the head of the Main Factory Committee.

These committees are in all cases of an advisory character. I find that six men form the ideal committee as to size. Any larger number than this is liable to prove unwieldy.

The General Factory Committee.

There should be first a General Factory Committee, with the superintendent as chairman, formed to care for the most important questions arising in a shop. The members of this committee should be selected with great care, and with a view to having the brightest, most progressive men in the shop upon it. While of course it is advisable to consider the character of departmental work in charge of the different men when making the selection, so as to have experienced men on the committee, at the same time a serious mistake will be made if this is the only point observed when choosing them.

Ordinarily, the personnel may well consist of the chief designer of

product, the chief designer of tools or the head of the tool room (preferably the latter), the head of the cost department, and two or possibly three foremen. In the case of assistants, these should form part of the committee. They, however, should *not take the place of the foremen,* even if it be necessary to increase the number on the committee. Accurate notes of actions taken are of course necessary. A capable stenographer to act as secretary is always a valuable adjunct. Further, an efficient secretary can straighten out many a difficulty between meetings, and the knowledge of shop conditions he absorbs is of great value.

Work of this Committee.—As stated before, no hard and fast rules can be laid down relative to the work of this committee; but, generally speaking, it can well consist of the following:—

1.—Plans to standardize product, and consideration of new methods of design.

2.—Consideration of actual progress made upon new ideas already introduced into the factory. (A most important subject; for the way in which valuable ideas, bravely begun, can be totally buried and lost sight of in the press for the necessary everyday output is often discouraging.)

3.—Consideration of possible economies and the systematic planning of reduction in cost. The mere starting of a general discussion often opens up a surprisingly large field for this highly important work. Reports by foremen upon economies, decided upon at previous meetings, and assigned to them to put into effect, should invariably be required.

4.—Consideration of routine work, both stock and contract, and progress upon it. Thorough weekly reports fully covering this subject are of the greatest importance.

5.—Promotions. While naturally the superintendent should be the final authority to act upon promotions, the plan of having this committee pass upon them in an advisory manner proves most salutary. Not only is the management thus assured of the best possible selection of men for important positions, but also the workers far down in the rank will feel the effect of appointments based upon merit, and free from any taint of unfair influences of relationship or personal friendship.

Meetings.—The number of meetings to be held will depend upon the character of the business—usually two a week will suffice. But one point should be insisted upon: *There should be stated times for these meetings and nothing should be allowed to interfere with them.*

The tendency to slight the meetings after the plan has been in effect for a time and has straightened out the kinks is very strong.

Subsidiary Committees.

Most companies manufacture several different lines of product, or a number of important variations upon this product. Each line should have its own committee.

The men forming the Factory Committee should act as chairmen of these different Subsidiary Committees, their selection being determined by the character of their work and their experience. Each committee should be made up of the foremen handling that particular line of product. Very often other members of the Factory Committee, and especially the tool designer or tool-room foreman and cost man, should be called into these meetings, where possibly the same stenographer should act as secretary as in the case of the Factory Committee. At first glance, this may seem an unimportant point; but it is not so, by any means, when you consider how much information of great value to a first-class superintendent a bright man in this position will absorb.

Work of these Committees.—While the work of each of these committees is naturally restricted to the details connected with one branch of production, still the work done by the Factory Committee as applied to that particular line will naturally be handled by it.

1.—Standardization and new designs.

2.—Progress on new ideas already introduced, with reports from the foremen responsible for pushing them.

3.—Consideration of possible economies and reduction in costs. Full reports from foremen upon assignments relating to this work.

4.—Routine work, its condition and progress, with reports from foremen responsible, showing whether or not each job, be it stock or special contract, is making proper progress so as to meet delivery dates.

Job Bosses' Meeting.

Naturally, the next step is the foremen holding meetings with the job bosses. Some may think this an unnecessary refinement of the committee system. I regard it as an important link in the chain. Naturally, these men cannot be taken away from their work very often without crippling the output; but short and sharp meetings with them every two weeks are strongly advisable, for necessarily upon these men ultimately falls the responsibility for pulling many a project through successfully. Many a cherished plan of great im-

portance evolved by the head of the company will succeed only through their help; many a one will fail because of their opposition. Never forget, too, that these men are the backbone of the shop in labor troubles. They are the *future foremen,* and the development of the best ones amongst them is of prime importance.

General Foremen's Meeting.

A general "Foremen's Meeting" should be held once a month. In addition to the attendance of the foreman and assistant foremen, the presence of the members of the Factory Committee and of the superintendent should be required. Indeed, the presence of at least one of the higher officials of the company is advisable.

At these meetings the heads of the several committees should touch upon the important problems before their particular committees requiring solution. Many points relating to progress of important work can be profitably discussed. Each man should invariably be required to make a statement as to the condition of his own department, a statement whether or not he or his department is responsible for any delays or trouble in any other departments, and a further statement as to whether or not any other department is causing him or his department difficulty of any character. With the knowledge that they cannot deceive the well-informed committeemen before them, such a method of procedure soon develops many an interesting situation, and leads to the discovery of many a "Sticking Point." The discussion that naturally ensues soon leads to definite plans for the overcoming of these difficulties.

A most profitable part of this meeting is a discussion of departmental records for the past month. These records can include such subjects as "Economies Effected," "Costs Reduced," "Suggestions for Improvement," "Production Records," "Departmental Expenses," and many others of an intensely practical and beneficial character.

You may be sure that each and every foreman will strive to his uttermost to present a clean slate, a good record, if he knows that such departmental records will be openly discussed before his fellow foremen, the committeemen, the superintendent, and other officers of the company. I recall very forcibly my own animated and determined efforts to present a good record before such an audience, when I was the head of important divisions of work in several large manufacturing concerns. The existence of this spirit amongst the other heads of departments was also very evident. The average foreman

can present to any one man his side of any story very skilfully. It is an entirely different matter, however, to tell the same story before a body such as I have described. It must be absolutely correct, or it will be instantly contradicted.

In presenting matters before these bodies, very effective use can be made of folding blackboards. I continually use a type containing ten leaves, each leaf 36 by 28 inches. These fold together like a book. The entire set can be closed, and a lock placed on the cover. Their value is apparent. It has always been of much interest to me to note the effect upon the foremen when their names were placed upon the blackboard, and their assignment to any particular task shown thereon. The thought that "that blackboard" contained these data, and that in four weeks it would appear staring them in the face, always worried them, and aroused their determination to accomplish the task so as to have it "rubbed off the slate."

The Workmen.

That this system has a good effect upon the workmen cannot be denied. They are undoubtedly affected by it. The position of job boss becomes a more attractive prize to strive for. They soon see, too, that under such a system unfair selections to such a position by the foremen become very rare, inasmuch as a foreman will seldom risk recommending a man to the Factory Committee for promotion on any basis other than that of merit. The danger of being caught is too great; and then again, the rivalry between departments becomes such that the foreman very soon learns that he cannot afford to take such action, because he thereby immediately affects the efficiency of his department. He soon learns that under such methods inefficiency becomes apparent at an astonishingly early date.

I do not intend to deal at this point with a comprehensive plan for increasing the efficiency of the working force, for a thorough consideration of many other practical points, such as wage system, rate of pay, sanitary conditions, etc., is first necessary; but it is necessary to emphasize the fact that some such plan as that outlined is absolutely necessary *as a foundation to work upon;* for you must give the worker "his chance" to advance in fair competition with others in order to develop his latent efficiency.

Again, such a system assures the company that any policy affecting its workmen, which it desires carried out, *will be carried out.* I have often seen the humanitarian, fair-minded policy of the manager of a business so mangled, twisted, and torn out of shape by

superintendent, foremen, assistant foremen, and job bosses, that its original owner would never recognize it by the time it reached the men and began to affect their daily life.

Such a system cannot be equalled as, first, a discoverer, and second, a developer, of the strong men in the organization. After all, success in any project is only a question of "the right man," *first, last and all the time.* Consider how enormous is the practical benefit! What a method for pushing improvements, for controlling production so as to meet dates, for reducing costs, and, last but by no means least, for inspiring the foremen, job bosses and workmen to do their best, through their natural ambition, under a system that provides them with a chance to show their worth! How they will grow and expand under such conditions! The words *esprit de corps,* and "working for the good of the company," are no longer empty phrases, but are illustrative of a spirit of enthusiasm, of good fellowship, and of determination to do their level best, which constitutes the best asset the company has, and the greatest and strongest force that tends toward success.

Reports.

The necessity for comprehensive reports of varied character is, of course, obvious. The exact character of these reports and the ground that should be covered therein is not always so obvious. In fact, seldom is there found a system of reports that is really *comprehensive* and *logical.*

Any attempt to define a system of this character must be at first general in character because of the differing conditions in each business. I have, however, applied the fundamental ideas explained below to a number of lines, and have never yet failed to make a practical application of their meritorious features, although their form was greatly changed.

In developing such a line of reports, let us begin by considering what we need in the way of methods to increase the working efficiency of the concern, and what will enable us to oversee and check up thoroughly both production and sales conditions. First, then, we want methods for determining what *must be accomplished* in the production division—in the character, regularity, and volume of output, in the cost of production, in the development of new ideas or inventions to conquer competition, in the steady development of greater efficiency and reduction of costs. Second, we want methods for determining what volume of business must be secured, and what profit must be obtained, on each and every class of goods manufactured, in

each selling territory; what expense can be allowed to pile up while the goods are being placed upon the market. Next, we need methods by which the selling organization can be forced to meet these requirements and bring the necessary results.

In short, we must have plans and methods by which the manufacturer can first get a clear conception of what *should* be accomplished in each division of his business; and next, means by which he *can get a firm grasp upon the details* of his business so as *to force the accomplishing* of these longed-for results.

In general outline the reports must be:—the "Monthly Analyzed Profit and Loss Sheet," the "Sales Reports," the "Factory Reports" and the "Cost Reports." All will be more fully outlined as the discussion develops, but the scope may be outlined as follows:—

1.—The Monthly Analyzed Profit and Loss Sheet should show:—

a. Delivered sales, with proper divisions for each class of goods produced, and receipts of other character.

b. The factory cost of the goods in each division.

c. The cost of delivery, including freight and cartages properly classified.

d. The receipts and disbursements on all work of a character auxiliary to the main lines of production, such as repair departments, moving departments, etc.

e. The selling expense, divided into proper classifications for analysis.

f. The office and general expenses that can properly be charged against each selling branch or territory.

g. The division of general or executive expense of such nature that it cannot be charged directly against a branch.

The importance of this report will be immediately recognized. It provides an analysis that enables any manager to locate immediately *the points of profit* and *the points of loss, provided* the distribution of credits and debits is correctly made. It is the primary report upon which the balance of the reports are founded. While it may appear complicated, the business man knows that it is necessary; and the one who fears its complication can be assured that it can be developed very easily by ordinary methods of accounting and the inauguration of comparatively simple systems in the factory.

2.—The Sales Reports:—Coupled with the preceding report should be first, a comprehensive memorandum outlining in a simple manner the *necessary work* of the selling department, no matter how the goods are distributed upon the market. This report should show

what goods ***must be sold, at what profit*** they must be sold, and ***under what expense*** they must be sold, ***in order to secure the desired profit on the balance sheet at the end of the year.***. It is not a difficult matter for an intelligent man to take such a report as the outlined "Analyzed Profit and Loss" report, consider what profit his business *should show,* and calculate from this *the profit he should expect from each branch of it* in order to secure this profit, and under what expense it is *possible to run* in order that his gross profit from his sales may not be eaten up by selling and general expenses. A simple enough method of procedure, but one seldom taken. And often where this sensible calculation is made little real scientific effort is made to "hew to the line," to insist upon reasonable profits, to hold down expenses and to conduct the business along the lines which such an analysis shows are absolutely necessary.

The next report on sales needed is naturally the one *showing the actual results,* territory by territory; showing volume and profit secured and expense of getting the business. It is immediately apparent that a weekly (or in some concerns a daily) *comparison* of the actual sales results with the data showing the results that *must be secured* or—as I term it the "*must* data"—will prove invaluable.

There are naturally a number of sales reports of a different character from these two just outlined that should be secured from the selling end of the business, but they are amplifications of the main reports and will be touched upon later under the sales division.

3.—Factory Reports:—The discussion of factory reports will naturally follow the description of the factory system and so cannot well be elaborated upon here. They should, however, naturally give the first importance to exhibiting progress upon contract, special and stock work, weekly; showing clearly the location of this work in the shop and the steps taken to get it out on time. The manufacturer who is constantly harassed by tardy deliveries and hampered by the lack of such data, can hardly realize the effective use that can be made of such weekly reports. The knowledge of exact conditions, coupled with the devising of ways and means to overcome threatened delays, and constant pressure upon the factory, bring excellent results.

4.—Cost Reports:—Their extent will be determined by the character of the business. But, in general, fully analyzed cost figures sent to the chief executives for their scrutiny, comparison, and criticism, bring admirable returns. Let one of the higher officers bring into a committee meeting, or a general foremen's meeting, a set of fully analyzed cost returns upon some particular line of the product, and

begin to inquire of the different foremen present why their share of the expense amounts to "so large an amount," and there will usually follow a red-hot discussion that will throw many a valuable side light upon costs of production.

Again, with accurate cost and stock data it is not difficult to secure monthly stock inventories at least approximately correct. Of course, a perpetual book inventory which enters into the general accounting of the company can be devised. I find, however, that not one manufacturer in ten is willing to spend the necessary money for this. However, he would rejoice over a monthly inventory, secured without shutting the shop down, which, coupled with his profit and loss statement and the data contained in his general books, would enable him practically to secure a balance sheet of the company's operation monthly.

The other important reports upon output, departmental expenses and results, production methods, tool-room results, etc., will be treated later. Likewise the strictly executive reports. Keep in mind, however, that these reports are so effective because of the committee system. They should wherever possible be made up by the committee handling the different branches of the product. And you may be sure that your committee, composed of enthusiastic men whose reputations are at stake, are going to see that progress reports, cost reports, output and production reports, represent the very best that they and the shop can accomplish, when they know that these will be closely scrutinized by the heads of the company.

EDITORIAL COMMENT

THE results of the bidding on the Panama Canal are immensely gratifying to the friends of the work, and a final answer to those who feared that bidders would be wanting, or would be so few and so shifty that they would bid in collusion. The result puts the undertaking on a secure, practical foundation, and sets it so full and fair in the daylight that it will be hard hereafter for enemies to undermine it or for disease to develop within it.

We still believe that a whole-hearted acceptance of the contract plan—an out-and-out commitment of the entire enterprise on a straight contract basis—would have saved time, money, friction, and possibility of scandal. We fear that the Government's retention of functions and powers controlling supplies, labor, and transportation will keep the construction partly entangled with red tape, surrounded with the misunderstandings and delays which an independent contractor would avoid or eliminate, and deprived of the benefits of invention and initiative which have been the genius of success in large work heretofore. But we must be well content for the present that an agreement has been reached upon which capable and reliable men are content to bid, and that energy and purpose to carry the thing through are enlisted on both sides—the Administration and the contractors.

* * *

AT this important moment when the construction is at the point of entry upon the active stage, Mr. Waldo's article which appears elsewhere in this number has a special meaning. The great plans for the canal have been settled, after full discussion in which some of theablest arguments have been made in THE ENGINEERING MAGAZINE. The physical facts of the work as it stands are not in need of restatement at present. We do not need to review data and specifications. But we do profit by a report which gives us a vivid and convincing idea of the conditions on the Isthmus. Mr. Waldo's article brings a real whiff of wholesome atmosphere from the Zone.

The author went to Panama of his own initiative and with an open mind. He was inclined to be critical of departmental administration of engineering work, and certainly he was no partisan of the lock plan. He had no newspaper sensations to exploit, no disappointments to avenge, no rival scheme to promote. His voice is not raised to the grinding of an axe or the sharpening of a knife. He is convincing because he is himself convinced.

A sacred duty rests upon the Administration and upon every individual who has a voice or influence, to keep the enterprise as clean, as sound, as honest, and as capable as Mr. Waldo shows it now to be.

* * *

IF the United States within the next few years should see a great, even a revolutionary, extension of Government "interference with private business"—if we should swing away from reasonable individualism to unfortunate ventures in Government ownership and operation of all sorts of franchises and undertakings—it will not be because the people are converted by the public ownership propaganda. It will be because they are driven to wrath (fortunate for the land if it be not to riot!) by the cumulative evidence of what our once trusted and honored leaders of finance and industry have been doing with the properties and the opportunities under their charge. These men

have been free as nowhere else in the world, probably, to conduct their business in their own way—and what a way they have chosen! Never was a political "Ring" so gluttonous, so shameless, and so utterly without excuse for gluttony and shamelessness.

From the distance of a later age, Harrimanism may perhaps impress the student of economics as having been a strange mania. The present rapidly growing conviction is that it is a criminal mania. The vast recent change of public opinion towards the man who has amassed millions by Harrimanized methods may prove, although an indirect influence, still one of the most potent in changing the national ideals which made Harrimanism possible. As civilization progresses in a community, these unwritten standards of life and conduct become actually the most pervasive and the most effective in regulating the concepts and the actions of individuals.

But before that period is reached, there is sometimes an institution developed for summary dealing with freebooters on their own plane and by methods which they cannot mistake nor despise. It has commonly gone under the name of the Vigilance Committee. Experienced road agents are said to have been very quick to discern the first symptoms of the formation of such a body, and to regulate their conduct accordingly. The political application to be made of this analogy is that our great freebooting corporations should be equally discerning. The body politic is in a dangerous temper. There are many indications that for the highwaymen of high finance, the swift alternative is submission to the law or an economic lynching, possibly in some form beside which the proposals of the present Government ownership advocates might even seem mild.

* * *

PERHAPS the naïvest plea yet made for the ship subsidy bill is that of the New York *Sun*—in substance, let's try it and see whether it does any good; it may, you know! And yet the *Sun* is keen to tilt with the leaders of the tariff hosts.

It seems clear enough that the tariff and subsidy are in the same class. Both tax the many, directly or indirectly, for the benefit of the few, on the theory that the few (in turn) will confer—directly or indirectly—reciprocal benefits on the many. So far as the tax-receiving few are concerned, the game is sure and the profits certain; but with the tax-paying many the case is quite otherwise. Both protection and subsidy, in short, are essentially institutions of class privilege, leading on, as class privileges have always done, to selfishness, extortion, and overbearing on the one side, and to discontent and rebellion on the other.

The argument for the subsidy, however, is not as plausible as that for the tariff. Protection not only ensured profit to the home manufacturer; it excluded his competitors, The natural growth of the country afforded almost limitless markets. Success was practically inevitable, and the necessities of business forced the prospering proprietor to share with a limited circle of colleagues and lieutenants. But while subsidies may ensure profits to a few shipowners, they cannot perform the other vital function of the tariff—they cannot shut out competitors. Our ships and shippers must find patrons out there in the world. They cannot deal with them as the steel maker has dealt with the American buyer—"if you don't like what we offer, go without." The shipowners and masters, the merchants and bankers of keen industrial rivals, have been strengthening themselves in those markets for forty years, while our shipping and our export trade in manufactures were bound and delivered up, a sacrifice to our protective system. The subsidy is a poor crutch for their crippled legs—bad backing in a game with experienced contestants who are strong and sturdy, with both feet sound and solidly planted on the solid ground.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

CAPE-TO-CAIRO RAILWAY.

THE PRESENT CONDITION OF THIS GREAT LINE OF TRANSPORTATION THROUGHOUT THE LENGTH OF THE AFRICAN CONTINENT.

Sir Lewis Mitchell—Journal of the Society of Arts.

IN THE ENGINEERING MAGAZINE for October, 1905, there was an article on the Cape-to-Cairo Railway, in which it was stated that the rails had then reached Kalomo, about 100 miles northeast of Victoria Falls, on the Zambesi, and were being extended to Brokeu Hill, 260 miles farther on. Beyond Kalomo came some heavy work, notably the bridge over the Kafue River, about 1,700 feet in length, and the longest, as the Victoria Falls bridge was the highest, in Africa. The work was vigorously pushed, and in June, 1906, the first engine ran into Broken Hills, as had been predicted in the article above referred to.

The latest authoritative word on the condition and purposes of this vast enterprise is contained in a paper before the Society of Arts, in London, by the Hon. Sir Lewis Mitchell, which was discussed by Lord Milner, and other African authorities, and from which a few extracts are here taken.

As is well known, the idea of a line of communication and transportation between the southern and northern extremities of Africa had its origin in the brain of Cecil Rhodes, who, in the face of discouraging opposition, had the satisfaction of seeing his railway completed as far as Buluwayo, in October, 1898. Although his untimely death occurred when only a part of his plans had been carried out, his "immense and brooding spirit still quickens and controls" the great undertaking, and his lieutenants and followers are continuing the work along the broad lines laid down by him.

The railway runs from Cape Town in a general northerly direction through Kimberley, Vryburg and Mafeking to Buluwayo, a distance of 1,362 miles. From this point there is a branch to the eastward, through Salisbury to Beira, on the Indian Ocean, in Portuguese East Africa, but the main line runs northwesterly through the Wankie coal fields to Victoria Falls, on the Zambesi River. The river is crossed here by a great steel arch, over four hundred feet above the surface of the stream, and the road continues on through Kalomo to Broken Hill, about 2,000 miles from Cape Town. "Negotiations are now in progress for the construction of another section to a mine called Bwana M'Kubwa, and it is an open secret that a further extension to Kansanshi is under consideration, which would bring the line to the extreme northwest border of the British South Africa Company." The main road will ultimately run to the southern end of Lake Tanganyika, which is within 500 miles of Broken Hill. Lake Tanganyika itself, which extends 400 miles north and south, will form the next link in the line of transportation. From the northern end of this lake, the railway will run past Lake Albert Edward and Albert Nyanza through Uganda to Lado or Gondokoro, at the head of navigation on the Nile, with probably a branch line to Victoria Nyanza, so making connection with the Uganda Railway to the east coast. The distance from

Tanganyika to Lado is only about 600 miles, and from the latter point there is water transportation down the Nile for about 1,000 miles to Khartum, which is closely connected, by rail and water, with Cairo, about 1,300 miles away. It will thus be seen that by building only about 1,000 miles of railway, and establishing regular steamboat lines on Lake Tanganyika and the upper Nile, the whole 6,000 miles between Cape Town and Cairo would be open for the transportation of goods and passengers.

It is not expected, however, that the through traffic on this long line will be of the greatest importance. Mr. Rhodes himself did not anticipate this, but "what he rightly relied upon was the immense stimulus that the line would give to internal development, to cultivation of the soil, exploitation of minerals, greater facilities for occupation of land, and consequently a steady growth of the white population.

"It must be remembered that the British possessions in South Central and Central Africa embrace the bulk of the great plateau of the continent, a plateau averaging more than 4,000 feet above sea level, and hence suitable for occupation by Europeans, provided they are afforded the necessary railway communication to and from the coast. Take the case of Rhodesia alone. Vryburg, where our line begins, is at an elevation of 3,890 feet; Buluwayo, the principal town of Matabeleland, is 4,469 feet; Salisbury, the capital of Southern Rhodesia, 4,825 feet; while the Melsetter and Inyanga districts, from which an export of merino wool has already commenced, stand at between 6,000 and 6,500 feet.

"Over the Zambesi, in North-Western Rhodesia, formerly known as Barotseland, the plateau is still preserved. Kalomo, the chief town, is 4,090 feet above the sea; Broken Hill, the present terminus, is 3,988 feet above the sea. If we turn to North-East Rhodesia, we find the great Tanganyika plateau, much of it 5,000 and 6,000 feet above sea level, while the altitude of Sunzu has been stated by Mr. L. A. Wallace to be 7,393 feet, of Mamitawa, 7,239 feet, while the Nyika plateau rises to 8,500 feet.

"This is not a gathering of the Statistical Society, but I have troubled you with these figures because they do bear on the question of railway development and land settlement. The Cape to Cairo line is not a jungle line traversing steaming valleys and malarial swamps. It aims at conforming as far as possible to the route recommended by engineers, and what is it nowadays that engineers cannot do? It aims at following the contour of the African watershed, and I do not hesitate to affirm that, where the railway runs, there for the most part white people can settle, and in increasing numbers will settle. Thanks to medical science generally, thanks to the Liverpool Tropical School of Medicine in particular, the origin and treatment and even prevention of malaria are becoming facts easily obtainable. Mr. Rhodes lived to know this, and he relied, therefore, on ultimate closer settlement, and on the growing value of local or inter-station traffic in regard to passengers, merchandise and produce. The native races are childishly fond of travelling by rail. Throughout South Africa, they are a traffic manager's best customers.

"Then, of course, quick, cheap transmission of labour is facilitated by the railways, which are, in this and many other ways, a great developing and civilising factor." Instead of having to travel weary distances on foot and surmount almost prohibitive obstacles to reach places where he can be profitably employed, the native will now be provided with comfortable transportation to his work.

"The mineral and agricultural development of Rhodesia and districts further south will be immensely facilitated by the great trunk line, and its use will save the native from untold distress. More distant areas will be tapped, new industries will arise, new wants be created, and the whole of Africa will eventually benefit from the extension of the line. A great army of sightseers, missionaries, scientific investigators, sportsmen, boundary commissioners, police, and civil officials, will also reap the advantage of quicker communication.

"But it is, of course, on goods and produce that the line has mainly to rely, and the Chartered Company is now devoting its energies to the task of attracting white settlers, by whose co-operation trade and agiculture, as they develop, will gradually place the railways on a payable basis."

To this may be added some remarks by Lord Milner in the course of the discussion on this paper: Long before the whole line was completed, "the existing portions (and he was speaking now more especially of the South African portion, which was more particularly connected with the conception and the work of Mr. Rhodes)—would have fully justified all the great efforts which had been made to create them. It was the chief object of a line like that, not so much to connect its one extreme end with the other, as to connect those otherwise isolated points along the great backbone of the Continent, from which lateral lines ran to the coast, by which trade was developed. It was undoubtedly, in the first instance, the lateral lines which were of importance for trade. He desired the audience, however, to look at the difference between the position of having a number of points right up the centre of Africa connected with the coast by lateral lines and entirely isolated from one another, and the position which the trunk line created of uniting all those isolated points with one another, and creating internal roads of communication which alone could bind those isolated stations together. It was a matter of enormous importance anywhere, but its importance was all the greater in a country situated as Africa, and especially South Africa, was, in which the points of greatest importance were isolated points on the central high plateau, separated from one another by great distances. They might each have their separate communication with the sea, but the trunk line linked them together, and in that way alone could the scattered centres of civilisation in the heart of Africa be united into one country, and effectively brought within the influence of the British Empire."

THE ALCOHOL ENGINE.

THE POSSIBILITIES OF ALCOHOL AS A FUTURE SOURCE OF POWER, AND ITS INFLUENCE ON THE INTERNAL-COMBUSTION ENGINE.

Elihu Thomson—Electrical World.

WITH the beginning of the present year, the United States internal revenue tax on denatured alcohol was removed, thus making the question of alcohol fuel of immediate practical interest and giving commercial importance to the alcohol motor, and a timely article in the *Electrical World, by* Prof. Elihu Thomson, discusses the modifications which the internal-combustion engines will probably undergo in order to adapt itself more perfectly to the new fuel, and takes a survey of the field of usefulness of the alcohol engine, particularly as an economical source of power in country districts.

"In the ordinary gasoline engine of today, such as is employed in automobile service, there is no definite speed governing, and the charge is introduced into the engine by suction of air, which carries with it gasoline spray and vapor. The vaporizer depends for its action on the suction of the intake stroke. In some forms of gas and oil engines the fuel charge is definitely fed by a fuel pump, and with the hit or miss type of governing the pump charge is definitely set to an amount which will just produce the proper combustible mixture with the volume of air taken in at each intake stroke. In other cases the effective stroke of the fuel supply pump has been varied with variations in amount of air indrawn, but this becomes a very difficult matter in the case where the engine is driven under considerable variations of speed. For this reason, the internal combustion engine, either of the four-cycle or two-cycle type, as employed in automobile and similar service, which may demand wide variations of speed and power, now generally employs a throttled intake and a vaporizer supplying the fuel charge to the air just before it enters the inlet valve or passage. In the two-cycle engine the mixture is generally made before it enters the crank case, from which it is expelled in the scavenging stroke to drive out the exhaust gases and take their place within the cylinder, ready for compression and explosion.

"With gasoline as a fuel, which vaporizes at ordinary atmospheric temperatures, warming of the vaporizer or the entering

air has been resorted to only in special cases, but the difficulty of obtaining grades of gasoline of the lowest boiling points together with the variation in effect when the outside temperature is low is tending to compel attention to the need of a warmed vaporizer. This is all the more so when engines of enlarged capacity are used. If the fuel in the vaporizer is of higher boiling point, the vaporization is then rendered effective by simply raising the temperature of the vaporizer, or raising the temperature of the fuel as it enters the air with which it is mixed; or while raising the temperature of the fuel also raising the temperature of the air somewhat so that it may the more easily take up and carry the vapor of the less volatile fuel.

"In the case of denatured alcohol, which it is hoped may become available at a reasonable price before long, the same form of vaporizer as that used with gasoline will satisfy the conditions, except that it will receive a preliminary heating so as to confer upon the alcohol vapor the same degree of volatility as is possessed by gasoline at ordinary temperatures. In the same way, by raising the temperature of the vaporizer still more, it is quite possible to use liquid fuel of much higher boiling point, or even kerosene oil. The writer has, in fact, repeatedly run an engine with the vaporizer arranged to have its temperature controlled, and employed gasoline, alcohol and kerosene oil interchangeably. An engine starting cold with an arrangement for allowing the exhaust gases to heat the vaporizer may burn a small amount of gasoline at the start, and on the attainment of a temperature sufficient to vaporize alcohol, the alcohol may be gradually turned into the vaporizer, and if the arrangement is such as to still further increase the temperature of the vaporizer, kerosene oil may finally replace the alcohol. But it is hoped that it will not be necessary to go so far.

"It will doubtless take considerable time, possibly two, three or more years, before the arrangement or organization for the production and distribution of the denatured spirit is sufficiently perfected to give us the product at a price which will compete with that of gasoline in the denser populated districts where the methods of distribution of the oil products are already in a high state of development. In the more sparsely populated districts, however, where, on account of the distances for distribution and inconvenience of storage gasoline now commands an advanced price, it should not be long before denatured spirit should be able to compete. It is fortunate that in spite of the considerably less heat value possessed by alcohol, as compared with any of the oil products such as gasoline, the efficiency of the engine may be increased in the case of the alcohol by increasing the compression so as to make up the difference. The limit of compression in the ordinary type of engine is naturally dependent upon the pre-ignition point of the charge during compression, and inasmuch as there is always a certain amount of the prior heated exhaust gas mixed with the new charge, while the cylinder walls are also necessarily at a considerably higher temperature than is the water in the jacketing, or than is the radiating metal where air cooling is employed, it is obvious that pre-ignition, when the heavier vapors are employed, must be regarded as setting the limit of compression which is feasible. Upon this degree of compression, however, the efficiency of the engine in large measure depends. With the employment of alcohol the compression may be so raised that two things are accomplished: first, there is a greater extraction of energy on expansion, resulting in a cooler exhaust; second, the cooler gas which remains in the cylinder and is mixed with the new charge results in further rendering pre-ignition improbable. It is true also that such a mixture would stand higher temperature of the walls of the combustion space without pre-igniting; consequently an alcohol engine can be run with the water boiling vigorously in its water jacket, a condition which almost invariably leads to pre-ignition difficulties with oil engines or gasoline engines unless the compression be kept quite low. It was noted in the Banki experiments that with oil engines the introduction of a certain amount of water in the form of steam or spray along with the fuel charge increased the efficiency of the engine. The commercial alcohol in any case will contain from 5 per cent. to 10 per cent. of water, and in the writer's experiments there was a tolerance of 15 per cent, to 20 per cent.; or in

other words, about 80 per cent. alcohol could be used. Below that point the ignition became somewhat irregular.

"There is no need to dwell here upon the superior safety of alcohol owing to its higher boiling point and its condition of being perfectly miscible with water in all proportions. It is probable that the first development in the use of alcohol as a fuel for internal combustion engines will take place in farming districts or remote districts where gasoline itself is very high in price. It is also probable that at first the engines may be used with mixtures of alcohol and gasoline in varying percentages with a gradual increase in the percentage of alcohol as its price goes down and the price of gasoline rises. In this way a gradual adaptation of the conditions may take place and the present production of gasoline be spread over a fuel consumption of very much larger amount. The introduction of alcohol may, therefore, be said to practically make it possible to extend the use of gasoline. There is, of course, at present a field for the application of alcohol engines in such places as Cuba, which already possesses cheap alcohol fuel, these engines often being employed for driving dynamos for lighting or power transmission upon plantations or upon country estates, and it can confidently be expected that as soon as the conditions are such that the price of alcohol in the United States is brought down to a figure as low as that of gasoline in any section, a great opening for the use of alcohol engines will be made. It would certainly seem to be an ideal engine for use in agricultural districts for farm machinery and the like. It is quite probable that in districts where even water for cooling is scarce, air cooling may be resorted to with perfect success. At the same time alcohol would relieve boat propulsion by the internal combustion engine of a considerable proportion of its dangers when gasoline or highly volatile hydrocarbons are used.

"As a fuel for the operation of small or moderate capacity isolated plants, alcohol will undoubtedly find extended application. As such plants will run for a number of hours at least, after starting, the question of preliminary heating of the vaporizer will not constitute a disadvantage of any moment. The preheating can be accomplished in a minute or two without any risk by separately heating a mass of metal (as by an alcohol torch) and placing it in contact with the metal of the vaporizer itself, and the heated metal piece may be made to jacket or closely surround the vaporizer with considerable surface in contact with the same and if needed its outer exposed surface be covered, permanently or temporarily, by a non-conductor of heat such as asbestos. Electric ignition of the make-and-break type or of the usual jump spark type may, as with gasoline, be applied. There would be no possibility of interruption due to freezing, as is the case when gasoline carries a little water, which later congeals in the passages. Moreover, since the alcohol engine can be used with the jacket water at boiling temperatures, the heat of the jacket, supplemented as it can be by the exhaust gases applied to further heat or to boil water or vapor, may be used in winter for steam heating or hot water heating, either alone or in conjunction with existing plants for that purpose. There is no need to dwell upon these possibilities, all so conducive to economy of application of the fuel."

CANADIAN SILVER MINES.

AN ACCOUNT OF THE DISCOVERY OF THE MINES AT COBALT, ONTARIO, AND A DESCRIPTION OF THEIR PRESENT CONDITION.

W. J. Blair—Engineering Society of the School of Practical Science, Toronto.

THE recent flurry in Nipissing mining stock has directed popular attention to the district where these properties are located, and it will therefore be of interest to read a description of the Cobalt region and the present condition of the mines there, as given by Mr. W. J. Blair, in a paper before the Engineering Society of the School of Practical Science, Toronto, and reprinted in the *Canadian Mining Review.*

"The town of Cobalt is situated in the

Township of Coleman, about five miles from Lake Temiscaming. It is on the new Government railway, The Temiscaming and Northern Ontario, one hundred and three miles from North Bay and nearly straight north from Toronto, three hundred and thirty miles. These rare deposits of valuable mineral lay from decade to decade within a very short distance of this large lake, so well known to the earliest voyageurs and frontier missionaries. They are within four miles of a wagon road used for a quarter of a century by the Hudson's Bay Company, between the Montreal River and Lake Temiscaming. It is twenty years since the meridian which forms the east boundary of the township of Coleman was run by O. L. S. Niven, and nearly as long since C. D. Bowman, O. L. S., subdivided the township of Bucke, which adjoins Coleman on the north. Both these surveys were within a mile of Cobalt. For many years lumbering operations were carried on right on top of these deposits. In fact camps were built within a stone's throw of a spot where over $1,000 worth of nuggets of native silver were picked off the surface. But it was left until July, 1903, for the first real discovery of mineral in the Cobalt district to be made.

"It was made by two men connected with the construction of the Temiscaming Railway, the spot afterwards becoming The McKinley-Darragh Mine, after the discoverers. This claim was not surveyed nor recorded at the time. Other discoveries made during the same year were the La Rose vein, the Little Silver vein, and the large vein on Cobalt Hill. No development work was attempted during 1903. An examination of the deposits and the immediate vicinity was, however, made under the direction of the Bureau of Mines, and this examination showed that they were extremely rich. As a consequence a careful geological survey of the district was begun in the spring of 1904, and instructions issued for the survey of Coleman Township.

"With the opening of spring, a half dozen or so prospectors were attracted to the locality and two important discoveries were made in the month of May. These are on Mining Location J. B. 6, and J. B. 7, and are what are now known as the Trethewey mine. No other discoveries are noted until July of the same year, when we have those in the immediate locality of Cross Lake. A few weeks later the first discoveries were made in what is now known as the Kerr and Giroux Lake Belt. This brings us to October, 1904.

"Up to this time, no development had been done except on those discoveries mentioned as having been made in 1903, and on the vein on J. B. 7. The steel on the Temiscaming Railway did not reach Cobalt until late in October, and it was some time after this before the first car of ore was sent to the sampler. The winter of 1904-05 saw things progress quietly at Cobalt. On the properties, when development was started, work was carried on steadily, and occasional shipments made. With the spring of 1905, however, things put on a new appearance. The mining world had heard a little of Cobalt, and outsiders began to come in. Prospecting began in earnest and new properties were opened. Developed properties began to prepare for more extensive operations. The town of Cobalt began to grow. The obstacles which nature had put in the way were met and overcome. It might be said that up to this time, the discoveries made were accidental; at any rate all had been made on the bare exposed rock. Systematic work, trenching and clearing away moss, etc., was then begun and throughout the known mineral area discoveries of proven value are now numerous.

"At present the following are shipping mines. For their relative location a map of the locality may be consulted: The Buffalo mines, (Dennison), the O'Brien mines, the Earle mines, the New Ontario (Trethewey), the Savage mines, the Temiscaming and Hudson Bay, the McKinley and Darragh, the Violet mine, McLeod and Glendinning, the Watts, the Victoria, the University, the Silver Leaf, the White-Silver, the Kerr Lake Mining Co. (Jacobs), the Drummond Mining Co., the La Rose, the McLeod-Lawson.

"Besides these, there are some five or six other properties which are in early stages of development, but which can hardly yet be considered shippers. As to the value and quantity of the output, the writer is not in a position to state with any

exactness. It would not be extravagant to place the value at from $2,500,000 to $3,000,000, and the average value per ton at $800 to $1,000. This would give in the neighborhood of 3,500 tons, or at 20 tons to the car load, 175 car loads.

"It is not the purpose of this paper to enter into the geology of the district. A complete description of this is given in the recently published report of the Bureau of Mines, Part II. The ore practically occurs in small veins of white or pink calcite in a slaty conglomerate rock of the Huronian series. A few veins are, however, found in the adjoining diabase. The metals occurring in economic quantities in these ores are arsenic, cobalt, nickel and silver. Other metals which have been found associated with these in the same veins are bismuth, copper, iron, lead, zinc and gold. The ore bodies are so variable in their composition that it is difficult to give even approximately the percentages of the metal. However, taking averages off car lots, we may quote the following: Silver, 2 per cent. to 12 per cent.; cobalt, 3 per cent. to 15 per cent.; nickel, 3 per cent. to 15 per cent.; arsenic, 30 per cent. to 60 per cent.

"Those who are familiar with the history of the Cobalt camp and what has been accomplished there, have no fear of its future. However cautious the experiences of other camps in Northern Ontario would teach us to be, there can be absolutely no doubt that Cobalt is a reality. It has already been proven so. The greatest depth that has been reached by any shaft is at the La Rose mine, where they have gone to a depth of 185 feet (or, according to latest reports, 300 feet). This alone, so far as this property is concerned, proves its value to be in the millions, while the diamond drill has shown that 185 feet is far above the known depth of mineral. There are several other shafts down to a depth of 100 feet, and they show no sign whatever of giving out.

"Up to the present, practically all the ore has gone to New York City and to Newark, N. J. It is shipped in sacks containing from 75 to 150 pounds. This unique ore presents very many difficulties to the smelter. The peculiar combination of cobalt and nickel causes the greatest trouble, and this is augmented by the presence of arsenic. Owing to this fact, up to the present, the producers have not been able to realize the full amount of silver values. They have been able to realize very little on the cobalt and nickel, and nothing at all on the arsenic and other metals above mentioned. The greatest problem that confronts the mines at present, then, is the economical smelting and refining of these products.

"The question is often asked, What is the likelihood of the mineral area widening so as to extend for several miles on all sides of Cobalt? Like many other questions asked about these deposits, the answer must be one which leaves the enquirer without any added information. The conglomerate rock wherein the mineral most frequently occurs at Cobalt is, roughly speaking, the country rock for fifty miles on all sides. This will seem encouraging to the prospector who is just starting in, and yet perhaps is not much of a comfort to the many who spent the summer of 1905 with shovel and pick and hammer and drill on the rocks of Temiscaming. Cobalt bloom, and in most cases the ore cobalt (smaltite), have been found in the following places, viz.: west side of Bay Lake (near Trout Lake); on the east side of the Montreal River, near Bay Lake in Lot 19, Concession IV., Coleman Township, close to Bay Lake; in very many places in Bucke Township; in the townships of Firstbrook, Dymond, Hudson, and Lorrain, in several places in Lots 9 and 10, Concession VI., Ingram, and in the unsurveyed territory north of the Townships of Ingram and Pense. It is also reported that the same indications have been found near Lake Kenogami, north of the Township of Burt. From this it would appear that the field is likely to be very large. However, nothing of value has been proved in the case of these last mentioned discoveries, and none of them appear to run above a few ounces per ton in silver values. These facts, however, ought to encourage rather than to discourage, when we remember that the first discovery of mineral on Lake Temiscaming was made over a century ago, and is probably what is now known as Wright's Mine on the east shore."

FLOOD CONTROL AND WATER SUPPLY.

A PROJECT WHICH PROVIDES FOR THE CONTROL OF THE PASSAIC RIVER AND THE CONSERVATION OF ITS WATER SUPPLY.

Morris R. Sherrerd—New Jersey Sanitary Association.

NORTHERN New Jersey is well favored in its sources of potable water, some of which have been so drawn on that most of the communities there are fairly supplied for the present. But in the future a more complete utilization of the available supplies will be necessary, and a recent project not only promises to provide an amount of water amply sufficient for many years to come, but at the same time furnishes an effective means for controlling the floods of the Passaic River, which have already done so much damage, and which would be even more costly in the future, as the valley becomes more densely populated.

The broad features of this project, which provides for a dam at Mountain View, thus creating a reservoir covering part of Pompton Plains, on the Pompton branch of the Passaic River, are well described in a paper read by Mr. Morris R. Sherrerd, before the New Jersey Sanit ry Association, and reprinted in *The Engineering Record.*

"For many years the possibility of the conservation of the waters of the Passaic River, both for power and water supply purposes, has been discussed, and many reports have been made on the subject, p..rticularly in connection with the Geological Survey of New Jersey, but it was not until the devastation which was occasioned by the recent disastrous floods on the Passaic River, namely, those of March, 1902, and October, 1903, made the question of flood control one of sufficient importance to warrant a thorough investigation of the possibility of such control, that the subject received as much attention as its importance deserved. The field work of the Passaic River Flood District Commission is completed, and careful surveys to determine the cost of the construction of a dam at Mountain View, N. J., both on the basis of flood control and conservation of water, have been finished. The compilation of these data in satisfactory shape for presentation to the public is still in progress and, therefore, it would be somewhat premature to do more than give a general outline of what the possibilities are in connection with the subjects under investigation.

"Any adequate plan for flood control on the Passaic River must of necessity provide sufficient storage to hold back and retard the flood discharge through the lower valley below Little Falls so that the amount of water, which is allowed to pass down the river, may safely be carried by a reasonable adjustment of the present restricted channel.

"In the report of the Northern New Jersey Flood Commission submitted to the Legislature in March, 1904, this whole subject was thoroughly discussed and the conclusion of the Commission was that while the construction of a reservoir with a dam at Mountain View of sufficient height for flood control purposes was estimated to cost $3,460,000, which would be about $900,000 more than the cost of the construction of a retarding reservoir with a dam located at Little Falls, still the former location would lend itself so admirably to conservation purposes that it would be a much more satisfactory location and eventually work out much more economically than the Little Falls plant."

As the cities of this part of New Jersey already have a supply of water sufficient for their present needs, they can hardly be expected to finance this project now, but as the matter is one affecting the prosperity of the State as a whole, it is proposed that the State shall issue bonds to provide funds for the undertaking. This would be possible, under the State constitution, if the interest and sinking fund for such bonds be taken care of without pledging the State's revenues, and provided that a law covering this special case be passed by a majority vote of the people of the entire State.

"The essential requisite for making an immediate development or conservation of water on the Passaic River self-sustaining it to procure at once a customer for the

water which can be so cheaply stored. Since the cities of New Jersey in this vicinity are now supplied, but since their needs will gradually increase, if an immediate customer can be found outside of these cities, it would be essential that such customer should only be supplied for a limited time and with a decreasing quantity. These conditions are exactly met by the present situation in New York City's water supply.

"It is true, as shown in reports on the water question in New York, that the present draft on its available reservoirs is now from 40 to 50 million gallons per day above the maximum yield of its watershed developments, based on recent dry years. This deficiency will rapidly increase, and unless stringent measures are resorted to to reduce the consumption this ratio of increase will approximate 10 million gallons per day per year, so that at the end of five years the deficiency will be in the neighborhood of 100 million gallons per day. It is also variously estimated that no additional water will be available from the new sources of supply for New York City in from six to ten years.

"From the above it seems to be a fair deduction that New York could reasonably afford to pay, as an insurance against a water famine, on the basis of say $25 per million gallons for an available supply of 100 million gallons per day, which it might demand for immediate delivery. This would amount to over $900,000 per year, and upon a five per cent. capitalization would seem to justify an expenditure of 18 million dollars.

"The Pompton Plains reservoir, with a capacity for the supply of 200 million gallons per day, will cost about 6 million dollars, and it would of course be necessary that some pipe line be constructed to deliver a temporary supply to New York City. This part of the suggested plan has not been worked out in detail, but may be roughly stated as possible of accomplishment for a further expenditure of five million dollars for pipe line, the route of which should be so selected at to make at least three-fourths of its length available for distribution within the New Jersey territory. The construction work of the Pompton Plains scheme could be finished within two years.

"It may safely be said that nowhere within 50 miles, and possibly not within 100 miles of New York City, can a large storage of potable water be obtained at so little cost per million gallons as would be the case from storage on Pompton Plains. The available storage by the Mountain View dam from a drainage area of 380 square miles, reserving sufficient capacity in the reservoir for flood control, would still be in the neighborhood of 60 billion gallons. Comparing this with the Pequannock supply for the city of Newark, the drainage area is about six times as great and the capacity slightly more than six times that of the storage reservoirs in the Pequannock watershed. The yield from the Pequannock has been carefully measured, and with its present storage is sufficient for a yield of 50 million gallons per day. If the same ratio of yield is applied to the Pompton Plains reservoir it will give a total yield of 300 million gallons per day. The storage reservoir in the Pompton Plains scheme, being at the lower end of the watershed, would give a more complete development and a higher yield than is the case on the Pequannock. It is, therefore, safe to say that the yield at Mountain View, even with the diversion of the Pequannock, which is in the same watershed, would still be sufficient to give 280 million gallons per day, and possibly as high as 300 million gallons for the driest year. And if 80 million gallons of this development were allowed to discharge down the Passaic River, which would be augmented by the natural flow of the waters of the West branch, the low flow of the Passaic at Little Falls and at Great Falls would be increased above its present flow, and there would still be left for sale or actual diversion from the Mountain View development 200 million gallons of water per day. If this could be obtained for six million dollars, the cost would be $30,000 per million gallons for the Pompton Plains storage as against the cost of about $80,000 per million gallons for the 50-million-gallon development on the Pequannock, which is considered to be an exceedingly reasonable cost. For the new supply for New York City which is being obtained from the Catskill watershed this relative cost will be $200,000 per million gallons developed,

and for the new supply for Jersey City it approximates $100,000 for its 50-million-gallon-per-day development.

"Summing up the above, an expenditure of 11 million dollars is needed to accomplish flood control and the conservation of at least 200 million gallons of potable water per day, for which it should be possible to obtain an immediate customer for 100 million gallons and an annual revenue of $900,000 and as the needs of New York City would gradually be supplied by its own works, the cities of New Jersey would become customers of the State. As the prices received from this latter source would, of course, be much higher than that charged for an insurance supply, there would only be a few years intervening between the termination of contract with New York City and the time when the New Jersey cities would be returning an adequate income to pay the interest, sinking fund and cost of operation of the plant. By a proper financing of the scheme, it would seem to be susceptible of the creation of a surplus sinking fund during the early period, supplemented by the increasing earnings in the later period, which would adequately provide for the retirement of bonds issued for the first cost at the end of 35 years, particularly as a portion of the first cost will be provided for by assessments for benefits to be derived from flood control."

THE HELION INCANDESCENT LAMP.

A DESCRIPTION OF AN ELECTRIC LAMP HAVING A NON-METALLIC FILAMENT OF HIGH EFFICIENCY.

Prof. H. C. Parker and Walter G. Clark—American Physical Society.

LAST month attention was drawn, in these columns, to the recent rapid development in methods of electric illumination, several of the new lamps being described, and now still another incandescent lamp has come to the front, which possesses some remarkable characteristics, and of which an account was given in a paper by Prof. H. C. Parker and Mr. Walter G. Clark, before a joint meeting of the American Physical Society and the American Association for the Advancement of Science.

This lamp, to which the name of "Helion" has been given on account of the resemblance of its spectrum to that of the sun, was developed in the physical laboratories of Columbia University. The filaments of these lamps, while not metallic, can yet be operated at a specific consumption of one watt per candle at a temperature which is much below that of metallic filaments when operated at this efficiency.

"The Helion filament is composed largely of silicon which is reduced and deposited, together with the other materials, under very exact conditions. The base which is being used at present is a special carbon filament, on which the necessary deposit is made. The filament is mounted within a globe which is then pumped out, much the same as with the ordinary carbon lamp. When current is applied, the first noticeable characteristic is the white light radiated from the filament at a current density at which the carbon filament would be radiating only red rays. The next characteristic is the whiteness of the light, and the high luminous efficiency of the filament at its normal current density, and next the overload or extra current which it will carry without breaking down. The filament, while not metallic in the proper sense, shows a metallic characteristic in that it is possible to fuse parts of it together very much the same as is done with a metallic filament.

"In early experiments with the filament it was noticed that a point of maximum candle power could be reached, and that further increase in current apparently did not result in a proportional increase in light. This has been borne out by pyrometer measurements, which show that the candle power increases with the temperature in practically a direct ratio up to a temperature (black body temperature) of approximately 1,720 degrees, at which point the curve flattens down, until it is practically flat at 1,800 degrees. In some experiments to determine the overload which the

filament would carry, the power applied has been increased by 100 per cent. after the point of apparent maximum brilliancy had been reached, the filament carrying the overload without rupture.

"A curve is given showing that the temperature-coefficiency of the filament is at first negative; the resistance of the filament drops from 32¾ ohms at 1,125° temperature, to 26¼ ohms at 1,375°, then increases to 27 ohms at 1,720°, and has a slight negative coefficiency beyond this point. The test shown on this particular curve was made on a short section of a regular filament. It will be noticed that the change from the positive temperature coefficiency to a negative coefficiency, takes place at practically the point at which the ratio of temperature to candle power makes its greatest change. The change occurring at this point would seem to indicate that a molecular alteration had taken place in the filament, but if this is so, it would appear that the same change occurs in a reverse order as the temperature is reduced, for when the filament is allowed to cool and power again applied, the same characteristics are observed.

"The amount of overload the filament will withstand is well shown in a lamp where long copper wires were used to place a small loop filament into the middle of the lamp bulb. The current passing through the filament was raised to a point where the copper wire on one side fused, ran down, and now appears as a metal globule near the neck of the lamp. The cement terminals are intact, and a portion of the copper yet remains at each cement terminal, the copper having fused immediately at the cement covered terminal. The overload does not appear to have in any way injured the filament, which is still intact, and the only discoloration on the glass is a slight deposit of copper on the side near the fused terminal, there being no deposit from the filament on the glass, although the cross section of the copper wire is several times greater than the cross section of the filament."

There is a curve which shows the relative intensity of light from a Helion filament and a standard make of carbon filament lamp at various wave lengths in the spectrum, each lamp being operated under normal conditions, and another figure which indicates the energy consumed by the same two lamps in producing this luminosity curve. It will be noticed that the Helion energy curve is the smaller one, while its luminosity curve is much greater than that of the carbon filament. The greatest degree of luminosity for each lamp appears at a wave length which is between the yellow and the green. This result seems to be due to some characteristic of the human eye, because a Welsbach mantle, the open gas flame, and other sources of illumination so far tried, all give a maximum intensity at this wave length.

"Sufficient time has not yet elapsed to give conclusive life tests on these filaments, but out of the few tested, eight lamps have shown lives of from 485 hours to 1,270 hours actual burning. The lamps tested were all lamps originally made for other tests, and some of them had burned for a great many hours before being placed on the life test, and had been tested for candle power at various consumptions, etc. All were made, mounted, enclosed in the glass bulbs, and pumped out at the laboratory where the facilities for mounting and pumping were not the best, so that this life test does not show as good results as will probably be secured on new lamps placed on life tests without being strained by the other tests to which these lamps were subjected. That the life of the lamps tested was controlled to a great extent by the previous treatment the lamps had received, the condition of the terminals, and the degree of vacuum attained, is indicated somewhat by the fact that the lamp which failed at 485 hours showed a decrease in candle power of about 15 per cent. while the lamp which ran 1,270 hours showed a drop in candle power of only about 3 per cent. Several of the lamps ran more than 700 hours, and a number of them showed an increase in candle power over the initial candle power during some portion of the life. One lamp which ran 735 hours showed a gradual increase in candle power which reached a maximum of about 2 per cent. Each lamp was started at one watt per candle power, and the filament in each case parted either at or near the cement terminals or anchor, which indicated either

a condition of strain on the filament, or else that the cement acted upon the filament. In some cases it has been found that the cement which was being used at that time contained a low silicate, which combined with the filament and reduced its cross section near the terminal, causing the filament to part at this point. The lamp which ran 1,270 hours showed rather an interesting performance. The lamp was started at 37 watts and 37 candle power. At the end of 200 hours it began to show an increase in candle power, which increase continued until the candle power reached 40 at 400 hours, the wattage remaining practically constant at 37. At 400 hours the candle power began to decline and again crossed the 37 mark at 500 hours. The decline continued at a very slow rate, and when the last reading was taken at 1,230 hours, the illumination had dropped to about 35.5 candles, and the consumption was about 36.5 watts. This lamp failed near one of the carbon terminals at 1,270 hours of continuous operation. The only blackness or discoloration on the glass, perceptible to the eye, was a ring of brown color around the lamp near the base and opposite the terminals.

"From observations made up to the present time, the high efficiency of the Helion filament appears to be largely due to selective radiation, as the filament reaches a maximum whiteness at a comparatively low temperature, after which an increase in temperature to the 1,720° point increases the intensity of illumination, but does not appear to make very much change in the color of the light; but with a carbon filament the color and quality of the light shows a marked change as the temperature increases. In making some comparisons with the carbon filament, they were run up in temperature to the point of disintegration, but even at this point the light was very much more yellow than the Helion filament at its normal working temperature. It has been found possible to make filaments as low as 30 candle power for present commercial electro-motive forces of from 100 to 115 volts, of approximately the same length as carbon filaments. How much smaller units it will be possible to make is yet to be ascertained."

CHANNEL TRAIN FERRY.

A PROPOSED FERRY-BOAT SERVICE FOR CARRYING LOADED TRAINS ACROSS THE ENGLISH CHANNEL.

Engineering.

IN the search for comfortable and rapid transportation between England and the Continent, many schemes have been evolved, some of them highly fantastic, others based on solid engineering principles. Besides the methods of water transportation, which developed with the growth of marine engineering and naval architecture, there have been proposed an overhead bridge, with spans of 1,970 feet a submarine track carrying a traverser on which trains could be transferred, and numerous tunnel projects. The tunnel scheme, which formerly met with so much opposition on the ground that it would offer an easy path for the invasion of the "inviolate isle," has lately been revived under the benign influence of the *entente cordiale* with France, but still another project, which has reached such a definite stage that it will probably become a commercial reality in the near future, is described in a recent issue of *Engineering*.

This plan is for nothing less than a train ferry service, such as exists on the Great Lakes, in New York Harbor, in Danish waters and in other parts of the world. "Parliament has given its sanction to the system, and every detail of this has been settled, except the points of landing, both at Dover and at Calais, which will be settled by mutual agreement between both harbor authorities.

"The object of the ferry-boat service is not, for the present at all events, to take the whole of the Channel traffic. If the boats were destined to transport passenger trains, they would have to be fitted up in a way to afford the greatest possible comfort to the passengers while crossing, seeing that the passengers could not be allowed to remain in the carriages during

the sea passage for very obvious reasons—no ferry-boat has yet been built which does away with sea-sickness. Moreover, for passenger service, the ferry-boat speed would have to be at least equal to that of the fastest ships now running. The company intends to commence the new service by the carriage of goods liable to get damaged in transit by breaking bulk and repeated handling, such as flowers, fruit, early vegetables, and other foodstuffs, which could be carried all the way, when required, in aero-thermic wagons specially designed by the company for maintaining a constant internal temperature.

"The above objections with reference to passenger trains would not apply to trains-de-luxe, exclusively made up of sleeping-cars. For these an increased speed for the boat would not be absolutely necessary, while even a lower speed than that which now obtains in cross-Channel service would be more than compensated for by direct travelling.

"An essential feature of a ferry-boat service is an adequate staging at both ends for transferring the trains to and from the boat. A difficult point to be met in the construction of such a staging is to provide for the constant variations in level in service, as when each car, for instance, leaves it to enter the track on the ferry-boat deck. The difficulty is much increased by the difference of level due to the tides. At Calais the amplitude in the tides is occasionally of 7 metres (23 feet), which, should the movable platform have a length of 100 to 150 metres (328 feet to 492 feet), would give rise to a gradient of 1 in 14.3 or 1 in 20. Railway traffic on such a gradient over an unstable track would be surrounded with dangers.

"The staging which it is proposed to put down for the cross-Channel ferry-boat service is derived from an original design made by Mr. Thévenet Le Boul, consulting engineer to the Channel Bridge Company, the working drawings for which have been got out by the Fives-Lille Company. It is claimed that in this the difficulties we have briefly alluded to are overcome and the trains would be hauled by capstans fitted on the quay to a platform made to travel up and down in a framing in a line with the railway. The platform is supported by pitch-chains on an iron framework; the weight of the platform is balanced by counterweights fitted to the other end of the chains, with a view to reduce the motive power necessary for the up-and-down travel of the platform. The pitch-chains run on toothed wheels worked by electric winches. When the ferry-boat is berthed in a line with the centre line of the platform, the latter is raised or lowered to the ship-deck level, and is connected to the ferry-boat by a small hinged apron, which is jointed on the platform and made to fit in a recess cut in the boat-deck. The train is then hauled on to the boat by winches provided on the bow of the latter. This will not require any special mooring of the boat, seeing that any rise or fall of the latter will be compensated for by the varying incline of the flap, which incline affects only the vehicle that happens to be running over it at the time, and does not interfere with the shunting of the train, of which all the other vehicles remain horizontal. The unshipping of a train from the boat to the platform would be carried out inversely with the aid of winches mounted near the land end of the latter. The required electrical energy for these various operations is to be supplied by dynamos driven by an engine on the ferry-boat. The utilisation of the latter for this purpose is rational, seeing that the boilers on board would, of course, be under steam during such time as the ferry-boat was at the landing-places loading or unloading.

"The principal dimensions of one of the proposed ferry-boats are: Length, 298 feet, 6 inches; breadth, 39 feet, 4 inches; depth of hold, 23 feet, 9 inches; maximum draught loaded, 9 feet, 10 inches. It is to be built of mild steel, and to carry sixteen cars on two lines laid on a steel deck, inside a covered way built of steel plates. The cars are to be held fast to the deck-rails each by four cramps, with chains round the buffer-cases, and by two stretching-screws.

"The draught of water, loaded, could be increased and still enable the boats to enter Calais Harbor at all tides; but as now designed the boats have a wide beam, and their seaworthiness is fully insured, notwithstanding their top-hamper. They have a surplus of stability which may even-

tually be taken advantage of when the final working drawings are passed for construction, to reduce the weather-roll. The promenade deck is to be fitted with saloons for the use of the passengers who would prefer leaving their berths in the sleeping-cars during the crossing, and for the passengers travelling from one harbor to the other. Access is had to these saloons by covered gangways, which afford complete shelter. Second and third-class cabins are to be provided below the main deck."

THE FLOTATION PROCESSES.

DETAILS OF THE NEW METHOD OF ORE SEPARATION AT BROKEN HILL, IN NEW SOUTH WALES.

W. R. Ingalls—The Engineering and Mining Journal.

BROKEN Hill, besides being one of the greatest mining districts in the world, has been the origin of some most valuable ore-separation processes. The very difficulties presented by the complex ores there have proved of benefit to the metallurgical world in general, by stimulating the ingenuity of engineers in devising new methods of treatment, which have often been found of wide application.

Among the most recent methods of ore separation successfully worked at Broken Hill are the flotation processes, which have excited wide interest, and will doubtless find extensive application in North America, the pioneer United States plant being already in operation at Marion, Kentucky.

The principal varieties of this process are those known as the Potter, the Delprat and the de Bavay. "In the Potter and the Delprat processes, the ore, finely crushed, is charged into an acidulated bath of water in a vessel similar to the ordinary spitzkasten employed in dressing works. An action takes place, however, which is precisely the reverse of what happens in the ordinary spitzkasten. Instead of the heavier minerals settling to the bottom, and the lighter minerals passing off, unsettled, with the overflow, in this new class of processes the heavier minerals are floated to the surface, while the lighter minerals sink to the bottom of the spitzkasten, whence they are drawn off.

"This extraordinary result is effected by the action of the acid in the water upon certain minerals in the ore, leading to the evolution of gas, chiefly carbon dioxide, the bubbles of which selectively attach themselves to certain minerals of the ore, giving them a buoyancy which causes them to float to the surface, where they accumulate in a scum, readily removable, and in this way enable a separation to be made.

"In the Potter process the bath contains usually two per cent. acid. The Delprat process was originally known as the "salt cake" process because of the use of sulphate of soda in the bath, but in its latest application this has been abandoned, and common salt (sodium chloride) is now used instead. The function of these salts is supposed to be to densify the bath, but this appears to be of doubtful, if any advantage. In the Potter process the bath naturally becomes densified to some extent by the iron and other impurities which are dissolved from the ore. The temperature of the solution in any case is maintained at about 80° C. Under these conditions, certain of the metallic sulphides, especially blende and galena, are floated up by attached bubbles of gas and form a coherent scum, which can be removed, leaving behind the earthy and silicious matter. When carefully carried out, the separation is practically a quantitative one in the case of certain ores.

"Besides the Potter and Delprat processes, the de Bavay process has recently attracted a great deal of attention, having been tried on a large scale with promising results. In this process no acid is used, the ore simply being gasified with carbon dioxide, which may be derived from chimney gases, and then fed suitably upon a surface of water, whereon the zinc blende floats while the quartz sinks to the bottom. The phenomena of this process are even less understood than are those of the Potter and Delprat processes. However, the de Bavay process is much slower in its action than either of the others, and is more costly, both in plant and in operation.

"Considering these processes solely from the technical point of view, it appears that in the treatment of the zinky tailings of Broken Hill, they have clearly beaten the process of magnetic separation, producing a higher grade of cencentrate, and at less cost per ton. Valuable information as to the efficiency of the Potter process is contained in a recent report by A. L. Queneau to the Zinc Corporation. After a great number of tests, the final one treated 1,300 tons of tailings and yielded 348 tons of concentrate, assaying 44 per cent. zinc, 8 per cent. lead and 8 ounces silver. The recovery was 81 per cent. of the zinc, 55 per cent. of the lead and 55 per cent. of the silver contained in the 1,300 tons of tailings. This concentrate was further treated by mechanical separation, producing a zinc concentrate containing 50 per cent. zinc, 4.3 per cent. lead and 8 ounces silver per ton, which consisted of about 88 per cent. of the first concentrate; and a lead concentrate (amounting to 12 per cent. of the first concentrate), containing 45 per cent. lead, 10 per cent. zinc, and 20 ounces silver per ton. Mr. Queneau added that with certain improvements he could increase the extraction of all three metals by another 5 to 10 per cent.

"These figures show that the flotation of the blende in the acid bath is more active than the flotation of the galena. The latter is fairly easy to float if finely ground, but owing to its high specific gravity, finer pulverization is perhaps necessary to float it completely. The chief separation that is made in the Broken Hill ores is between the blende and the gangue of the ore. As between the blende and the galena, the separation is less sharp, both being capable of flotation, but the galena to less extent than the blende, because of its higher specific gravity. Because of the different behavior of lead in the non-acid bath, the de Bavay process appears to be able to make a concentrate of considerably higher tenor in zinc than either of the other processes, the de Bavay concentrate rising to 50 per cent. zinc. My own experiments have shown that blende, galena and pyrite under certain conditions may be floated nearly equally well.

"The plant required for either the Potter or the Delprat process is of simple design, the essential apparatus resembling an ordinary spitzkasten. The ore, slightly moist, is delivered by a shaking feeder at one side of the spitzkasten and passes down into the bath. The heavy sulphides, which, under ordinary conditions would sink to the bottom, in the flotation process, because of the buoyancy of the bubbles of gas which become attached to them, rise to the top and flow off for collection, the spitzkasten being arranged for overflow both on the right-and left-hand sides. The supply of acidulated water is derived from a main passing over the line of spitzkasten, from which branches project down into the latter. The main leads from the storage tanks, into which the clear solution from the settling tanks is pumped for further use. In the storage tanks it is reheated to 80° C. by blowing steam into it. The gangue escapes continuously from the bottom of the spitzkasten, the flow being regulated by an adjustable valve, and is received on a belt conveyor, which transports it to the dump.

"The manipulation of the process is a delicate operation, because the adhesion of the bubbles of gas to the sulphide particles is not by any means a strong one, and in fact is maintained only so long as the bath is free from vibration; this necessitates an arrangement of the spitzkasten that will be absolutely steady; the slightest shock is sufficient to detach the gas and sink the sulphide. This fact is taken advantage of in the collection of the valuable minerals, the overflowing concentrate being dropped suddenly into a collecting tank. The gas bubble is thus disengaged, and the sulphide particles, being no longer buoyant, sink immediately and are caught for further treatment. The clear supernatant solution, drawn off from the concentrate, is returned to the storage tanks for use in the treatment of further quantities of crude ore. The output of each spitzkasten is, comparatively speaking, very large, as the size ordinarily used at Broken Hill is about 4 feet 6 inches square and 5 feet deep, and the capacity is approximately 6 tons per hour.

"The flotation process is comparatively cheap. One man attends to six spitzkasten, his duty being merely to see that the scum is floating off regularly and that

the tailings-discharge does not clog up. The rise of the scum is very rapid. It should accumulate in a dense mass about 1½ inch thick on the surface of the bath. Holes in the scum are evidence of irregular working. Mechanical skimming, or indeed any kind of skimming, is disadvantageous, the best result being obtained when the scum quietly floats off. The consumption of sulphuric acid in the Potter process is 30 to 35 pounds (computed as 100 per cent. H_2SO_4) per 2,240 pounds of ore. The acid solution loses about 30° F. in a circuit. The pumping and reheating of this solution, together with acid and labor, constitute the chief items of expense in the process. The total cost at Broken Hill, including loading the ore at the tailings pile (tailings being the material treated) and transporting it to the flotation plant, is only 50 cents per 2,240 pounds.

"As in the cases of magnetic separation and electrostatic separation, in flotation the treatment of very fine ore is also a difficult problem. Neither the Potter nor the Delprat process will treat slime; similar difficulty has probably been experienced in the de Bavay process, though it has not been definitely reported. This is because of the entanglement of the particles in rising in a muddy bath, the finest gangue failing to settle rapidly enough, the result being a dirty, low-grade scum. On the other hand, it has been found at Broken Hill that these processes will not give good results on particles larger than 0.5 millimeter, or such as will pass a 28-mesh screen. In these respects the de Bavay process appears to be similar to the Potter and the Delprat. De Bavay recommends material of 40-to 80-mesh size. Experiments and practice have, moreover, shown that in order to secure the best results there must be a certain ratio between the floatable and the non-floatable material. In some cases, blende which alone would not float, became buoyant after a certain proportion of quartz had been mixed with it; in other cases, an ore which alone gave a very good flotation, upon the mixture with it of a large quantity of sand gave a very bad flotation."

COLOMBO HARBOR.

AN ACCOUNT OF IMPROVEMENTS WHICH MAKE THIS CEYLON PORT ONE OF THE LARGEST ARTIFICIAL HARBORS IN THE WORLD.

Engineering.

COLOMBO, on the west coast of Ceylon, at the southern extremity of India, is on one of the great marine highways of the world. Besides being of great commercial importance, its situation makes it a valuable strategic point for the British navy, so that the improvement of its harbor possesses far more than local interest. The works which have been in progress there for a long time are now nearing completion, and are well described in a recent number of *Engineering*, from which some abstracts are taken.

"There is provided now, a harbor, having an area of 660 acres, with a depth at low water ranging up to 39 feet, and having two entrances, 800 feet and 700 feet wide respectively. Thus the largest merchant and naval ships may therein find safe anchorage. There, too, a British naval fleet could have its base, and it is consequently interesting to note that the harbor is practically equidistant between the Cape and Australia. The distance from Cape Town is 4,310 nautical miles, and from Aden 2,130 miles. Singapore is 1,560 miles further east, the distance to Hong Kong is about 3,000 miles, and the nearest harbor in Australia—King George's Sound—is 3,380 miles; Melbourne is 4,740 miles, and Sydney 5,310 miles distant; while Wellington, in New Zealand, is 6,210 miles from Colombo. Admiralty ships formerly used Trincomalee in Ceylon, but since Colombo afforded better accommodation for warships, it has become the naval headquarters, and in view of the splendid graving dock now available, repairing and overhauling facilities will be provided. The advantage of the harbor to the merchant fleet is proved by the fact that the number of ships frequenting Colombo increased in nine years by 55 per cent., and the tonnage in eight years by 52½ per cent.

"The idea of having a great national harbor on the coast of Ceylon originated forty years ago, when a proposal was made to construct artificial breakwaters, in order to enclose a large anchoring area at Point de Galle. As the aim was not only to meet the requirements of Ceylon, but to provide a coaling-station for ships trading between Aden and the Far East, Galle offered considerable advantages, as it is practically the most southern point of the island. But there were serious natural disadvantages: the heavy currents off the south coast of the island, added to the force of the cyclone, would have made the approach to the harbor frequently difficult, if not dangerous; and it is due to the great ability and perspicacity of the late Sir Hercules Robinson that Colombo was definitely chosen, notwithstanding that its position necessitates a further deviation of 18 or 20 miles from the course between Aden and the East than would have been the case had the harbor been at Galle. The late Mr. R. Townsend prepared an original scheme for the harbor, and in 1872 the late Sir John Coode was consulted, and designed the works which were carried out between 1872 and 1885—viz., the construction of the south-west breakwater, having a length of 4,210 feet, and the deepening of the harbor to 26 feet at low water. These works, the foundation-stone of which was laid by King Edward—then the Prince of Wales—cost 700,000*l.*, or about 70,000*l.* less than the estimate.

"Before the completion of this south-west breakwater, it was proposed to construct a north arm to shelter the harbor from long-shore winds from the north, which bring up a choppy, although not a dangerous sea. This north arm was to be an isolated work, extending from near the northern head of the south-west breakwater shorewards; entrances to the enclosed area were to be left at the outer and inner ends of this breakwater. Before a final decision was made, however, there had been a great increase in harbor traffic, and it was decided to so place the additional breakwaters as to materially augment the area to be enclosed. The scheme then formulated by the engineers, Messrs. Coode, Son, and Matthews, and now practically completed, gives a harbor of 660 acres, which is believed to be greater than any artificial harbor hitherto constructed. The national harbor at Dover provides an anchoring area of 610 acres, exclusive of the commercial harbor, 75 acres in extent. Instead of one, there are now at Colombo two new breakwaters, one having its root in the natural rock at Mutwal Point and extending 1,100 feet westwards, and known as the "North-East Breakwater." Seven hundred feet further westward there begins the north-west breakwater, 2,656 feet in length, which trends southwards to within 800 feet of the head of the original south-west breakwater. Two entrances are thus provided, the outer 800 feet and the inner 700 feet wide, the object being not only to facilitate the arrival and departure of ships, but to ensure a current through the harbor for sanitary purposes. The tidal range is only 2 feet at spring tides, so that the amount of water which would pass into and out of the harbor through one entrance, due to tidal propagation, would be relatively small; as there is a considerable population afloat in the harbor at all times, due to the presence of a large number of passenger vessels and of natives engaged in the work of the port, it was considered prudent to facilitate the circulation of the tidal water by the two wide entrances. This has had a beneficial effect.

"In addition to the construction of the breakwaters, a large area of land has been reclaimed, 24 acres of which forms a coaling depot, with storage for 250,000 tons of coal. In front of this, jetties have been built for the loading of barges, which convey the coal alongside the ships at anchor. Experience has shown that the most economical method of handling the coal is by sacks carried by the coolies. To the north of the coaling depot further land has been reclaimed, and will be available for works, which would thus be contiguous to the graving-dock constructed by arrangement between the Admiralty and the Government of Ceylon. The channel leading to this dock has a depth of 33 feet at low water of ordinary spring tides. The length of the dock is 700 feet. A slipway for the repair of smaller ships is included in the scheme, and an extensive fishery harbor has been constructed to the north of the main harbor.

"A further point to which general reference may be made is the proposal, now agreed to, for extending the south-west breakwater 2,000 feet northwards. This extension is made in order more effectually to protect the outer entrance to the harbor during the south-west monsoons. There are two monsoons—the south-west, continuing from May to October, and the other, the north-east, lasting from October to May. The latter, however, does not involve any material difficulty at Colombo. It is the south-west monsoon which brings extremely heavy seas; indeed, the breaking of the waves on this south-west sea-wall is the subject of one of the most effective and world-famed wave photographs taken. The new arm will thus prove a great protection to ships entering the harbor during the south-west monsoon.

THE BREAK IN THE COLORADO RIVER.

THE DIVERSION OF THE COLORADO RIVER INTO THE SALTON SINK AND THE ATTEMPTS TO CLOSE THE BREAKS IN ITS BANK.

H. T. Cory—Engineering News.

THE control of the lower Colorado River has become a question of national, and even international, importance. It has formed the subject of an aminated correspondence between the President of the United Sates and the President of the Southern Pacific Railroad, and has now been brought to the attention of Congress by a special message from the President. It is, therefore, of interest to understand what has caused the diversion of the river, which, if unchecked, will flood hundreds of square miles and create a great inland sea, and to see what has been done to close the breaks in the bank, and restore the river to its old course. In a recent issue of *Engineering News,* Mr. H. T. Cory, the general manager and chief engineer of the California Development Company, who has had charge of the latest attempt to close the break, gives an account of this work and of the situation in general, and further particulars are contained in an article in the *Scientific American.*

In order to understand the situation clearly, the geographical conditions must be kept in mind. The Colorado River rises in the Rocky Mountains and after flowing in a general southwesterly direction for a couple of thousand miles, in the course of which it passes through the Grand Cañon, it empties into the Gulf of California. For part of its course it forms the boundary between California and Arizona, and just below Yuma it crosses the international boundary, and completes the last ninety miles of its course in Mexico. This latter fact introduces a political complication into the question, for the breaks are on both sides of the boundary line, and the overflow is partly in Mexican and partly in United States territory.

"The Colorado is chiefly fed by the snowfall over the mountainous regions of its drainage area. It has a regular spring and summer rise, beginning, ordinarily, May 1 to 15, and continuing until August 1 or September 1—reaching its maximum between June 20 and July 15. Its lowest stage is in January, and the variation in its flow, throughout the year, is enormous—running from 2,600 to 120,000 cubic feet per sec. Its elevation at Yuma, ninety miles above where it empties into the gulf, is 118 feet above sea level, at normal low water, while at "The Needles," where it is crossed by the Santa Fé Railroad (three hundred miles above Yuma) its elevation is 600 feet above sea level. Generally speaking, after leaving the Grand Cañon, a short distance above the Needles, the river flows between low mountain ranges and foot hills, with its floor varying in width from many miles to a few thousand feet. Excepting at low water, it is heavily charged with silt, and, having such a steep grade, it often changes its channel to a remarkable extent. Just above Yuma it is joined by the Gila River—which is formed by the Verde, the Salt and the upper Gila rivers, all of which drain precipitous mountain regions in northern Arizona and the western part of northern New Mexico. Excepting when fed by the melting snows, this river is dry at Yuma, but cloudbursts and heavy rainfalls, extending at times over its entire drainage

area, make its flood discharge greater than the maximum of the Colorado alone. These flood rises in the Gila are not confined to any season, but the records since 1878 show that, within that period, sudden rises have occurred every year in each month from September 1 to May 1. In consequence, while normal low water stages in the Colorado, below the mouth of the Gila, are to be expected, sudden floods are always a possibility. Above the Gila's mouth, on the other hand, the flow of the Colorado can be closely forecasted."

Below Yuma, the Colorado, like the Nile, the Mississippi and other rivers heavily charged with silt, flows along a ridge of its own formation, due to the constant raising of its bed and banks, and the low earth banks have always been subject to overflow, which however, was formerly comparatively unimportant in its effects. To the west and northwest of this part of the river, there lies the Colorado desert, a large part of which is below the level of the sea, the lowest portion, having a minimum elevation of about 300 feet below sea level, being known as the Salton Sink. From this depression, a broad plain, having an average width of 40 miles, slopes gradually upward to the Colorado River, for a distance of 110 miles. It will be seen, therefore, that any water getting through the river's western bank will flow down channels in this plain, and eventually reach the Salton Sink if it is not absorbed in the earth or evaporated on the way.

"During unusually high water, a considerable portion of this plain was irrigated by the river's overflow, but, ordinarily, the overflow covered only the lands immediately contiguous to the banks, so that most of the plain remained absolute desert with no subsurface water, but with remarkably rich soil—requiring only water to make it one of the most fertile valleys in the world.

"In 1896 the California Development Co. was organized for the purpose of diverting part of the water of the river for the irrigation of many thousand acres of land in the Imperial Valley, which lies to the south of the sink. Actual work on the construction of the irrigating system was begun in 1900, and water was first applied to the land in June, 1901. The company took advantage of the opportunity to use one of the overflow drainage channels, known as the Alamo River, from the Colorado's bank westerly for a distance of over fifty miles. The first four miles of this channel parallel the Colorado closely, being but 800 to 1,500 feet away, and a dredger was used to deepen it sufficiently to take the water during the low stages of the river. A wooden headgate, 80 feet in length, was put in at the upper end—just above the boundary line between the United States and Mexico, but, owing to the necessity for getting water at a given time, the floor was placed 5 feet higher than originally planned, and too high to take water at the river's lowest stage. As a consequence, the canal—which was never made deep enough—silted up, and, although dredgers were kept constantly at work, it was impossible to deliver sufficient water to the settlers, who had made their homes in the valley in much greater numbers than was anticipated. Therefore, in September and October, 1904, a cut was made with a dipper dredge from the first bend of the Alamo River or main canal, where it turns away from the river to the westward, into the Colorado River itself, at a point opposite an island which here divided the river into two channels, the western, or Mexican, and the eastern, or American. This cut was 50 feet in width and had a grade of 1½ feet in a distance of 3,300 feet. It promptly silted up, was opened again, and again silted up. A third time it was cut, and, shortly thereafter, a rise in the river widened and deepened it to a dangerous degree."

It was then decided to close the opening, but it took six different attempts, extending over an interval of two years, before the break was even temporarily closed, and a month after the apparent success of the sixth attempt, the river made a new break, and conditions are now as threatening as ever. In the course of the two years, the main break increased to a width of nearly 3,000 feet, with a maximum depth of 24 feet, and a flow, normally of 10,000 to 15,000 cubic feet per second, and at one flood-time, of over 50,000 cubic feet. Some of the attempts to close the breaks, which, under ordinary conditions might have been successful, were destroyed by unexpected and remarkably heavy floods, and the work

could only be carried on to advantage at times of low water.

The method employed in the first attempt consisted in driving piling 3 feet apart, right across the break at the river bank, and filling between with brush and bags of sand. Unfortunately, the supply of sacks was exhausted, and before more could be secured the improvised dam gave way. In the second attempt, the procedure was to drive two rows of piling 15 feet apart, and then complete the barrier by filling in with brush and sand bags. It was found, however, that as the piles were driven from one side of the crevasse, the current eroded the opposite bank almost to an equal amount, and so, on June 14, 1905, this attempt was abandoned. The third effort was begun on July 14, 1905, and was directed to the closing of the western, or Mexican, river channel, as was the fourth attempt also, but on November 28, 1905, the second largest flood ever recorded in the Gila River made all this work useless.

On the fifth attempt, they went back to the break itself, which in the meantime had grown wider and wider. It had been decided by this time to build a reinforced concrete and steel headgate near the original entrance to the canal, just north of the boundary line, on a rock point jutting out of the foot hills, and to dredge out the old canal deep enough to permit all the water necessary for irrigation to pass down it. At the same time, a permanent earth dam was to be constructed across the break itself, but as the work on the old canal would necessarily take considerable time, it was decided to dig a by-pass around the dam and place there a wooden headgate. Before this work was completed, unusually high water carried part of the wooden headgate away, and caused the plans to be changed so as to involve the building of a rock-fill dam with the greatest possible speed.

This was called the sixth attempt, but was really a continuation of the fifth, and some of the details of these combined attempts give a good idea of the emergency work done there. "The first step was to lay a branch railroad from the main line of the Southern Pacific Railroad to the break in the river bank. This done, a series of side tracks was laid down for the storage of rock and other materials for the dam, the underlying idea being to attack the torrent of the river with a large force of men and abundant materials, and throw the dam across the breach with the greatest possible rapidity. For the construction of the dam there were assembled 1,100 piles, 2,200 cords of willows for mattresses, 40 miles of ⅝-inch steel cable, and 70,000 tons of rock. In addition to the rock, half a million cubic yards of earth had to be dumped into place, if the roaring torrent was to be thrown back into its proper channel. For constructing the dam, hauling the material into place, etc., there were assembled eight locomotives, an army of mules and horses, and over 1,000 laborers. The problem was complicated by the nature of the bottom over which the torrent was flowing; for it consisted of soft silt of unknown depth. The first step taken was to drive a row of piles across the torrent. A mattress was made of steel cables and fascines of willows, and sunk across the stream.

"The next step was to drive a strong pile railroad trestle 3,000 feet in length across the axis of the mattress, from shore to shore, with a side track at the center provided with switches for the passage of trains. When the preparatory work was finally completed, the task of building the rock and gravel dam was commenced, and rushed through with the greatest possible speed, night and day, until the breach was closed, and the river thrown back into its proper channel. The dam was advanced from both banks simultaneously. Long trains of gravel and rock were drawn out over the trestle, and their contents dumped as quickly as the men could pry the rock off the cars into the rushing torrent. As the ends of the two portions of the dam approached each other, the water increased in height and rushed with increasing velocity through the narrowing channel. All through the night of November 3, the men redoubled their efforts and by noon of November 4, after working for many hours unloading at the rate of five minutes to each carload, the final closure was made, and the mighty Colorado River, which drains some 230,000 square miles, was thrust back into its original bed, and again flowed down to the Gulf of California."

While the dam was being built, levees

were commenced extending along the river bank up stream to the concrete-steel headgate, and down stream for about five miles, but this work had not yet reached an effective stage when, hardly a month after the old break was closed, a new one was opened a little below the dam, and the river is again flowing down into the Imperial Valley and the Salton Sea.

"Estimates of the damage done by the inundation from the time of the first break include: the washing of 30,000 acres of rich land into the Salton Sea, and the injury of as much more by the formation of gullies or small cañons; and the destruction of four-fifths of the town of Mexicali, in Mexico; while some 50 miles of the Southern Pacific Railway track have been rebuilt at successively higher levels to avoid the encroaching sea. Furthermore, millions of tons of the salt which formed such a profitable industry in the Salton Sink have been covered by the silt in the bottom of the sea. The area of the Salton Sea is now about 500 square miles, and its greatest depth 78 feet."

If the Colorado River is not permanently controlled, not only will the entire Imperial Valley, with all its improvements, be jeopardized, and its 10,000 inhabitants driven from their homes, but the vast United States Government Laguna Weir, a few miles above Yuma, and the great irrigation project depending upon it, will be threatened with destruction. And the emergency admits of no delay.

DIRECT-CURRENT TRANSMISSION.

A DESCRIPTION OF THE LONG DISTANCE, HIGH-TENSION, DIRECT-CURRENT TRANSMISSION FROM MOUTIERS TO LYONS, FRANCE.

Elektrotechnische Zeitschrift.

ALTHOUGH electrical energy was first transmitted to a distance by means of the direct current, the alternating current soon acquired a monopoly of the transmission field, and for a long time it was thought that the use of direct current would be restricted to small areas where comparatively low voltages could be economically employed. But within the last few years, direct-current transmission has again come to the front. Some remarkable installations have been made and are in successful operation, and it is claimed that the voltages practicable with direct current will far exceed those that can safely and economically be used in alternating transmissions.

On account of considerations of safety and for other practical reasons, the alternating-current transmissions have hardly gone higher than 70,000 volts effective potential, and few have exceeded 50,000 volts. As these figures would correspond to maximum voltages of about 100,000 and 70,000, respectively, it can be seen that for this reason alone, direct-current potentials can be made higher than alternating, as their maximum and effective voltages are the same. Moreover, with direct current, the potential to earth can be reduced 50 per cent. by grounding the middle point of the generators which are running in series. In this way, it becomes possible to operate with line voltages of 150,000 to 200,000.

The direct-current transmission system which has, perhaps, been furthest developed, is that designed by M. Thury, of Geneva. He and his company have made steady progress, and have already installed a number of plants in various parts of Europe. One that attracted a great deal of attention was the Lausanne-St. Maurice installation, in which 6,000 horse power was transmitted 35 miles at a voltage of 27,000. Direct current is being seriously considered for transmitting energy from Victoria Falls, in South Africa, to the gold mines of the Rand, a distance of 700 miles, and M. Thury has been appointed on the commission of experts who will decide the general features of this great project.

The latest and most important installation on the Thury system which has been placed in operation, is that for transmitting power from Moutiers, near Grenoble, in the French Alps, to Lyons, a distance of 112 miles, and which is described in a recent issue of the *Elektrotechnische Zeitschrift.* The operating company, the Société Grénobloise de Force et Lumière, already

possessed two fully loaded polyphase stations in the vicinity of Grenoble, and for the present scheme built a new generating station at Pomblière, near Moutiers, in Savoy, which was to be used exclusively for the supply of Lyons. The hydraulic power was furnished by the Isère River, a fall of 215 feet being utilized. The available power is 6,300 horse power, and this is transmitted, in the form of high-voltage direct current, 112 miles to Lyons, where there are two receiving stations, one at the city limits in Vaulx en Velin, the other in the center of the town, in the Rue d'Alsace. These two stations are connected by an underground cable 2½ miles long.

At the power station there are four generating units, each of 1,570 horse power. Each unit has a terminal voltage of 14,400, and is composed of two pair of double machines. Each double machine has two armatures mounted on a common shaft, and two field frames on a common bed-plate, with three bearings. Each armature, therefore, generates current with a potential of 3,600 volts. The double machines are connected with each other and with the driving water-wheels, which are reaction turbines built by Piccard, Pictet & Co., by means of flexible couplings.

The field frames have six poles and are made of cast steel; the armature conductors are form wound, and are imbedded in slots. The machines have a speed of 300 revolutions per minute, and deliver 75 amperes at 3,600 volts. The elastic couplings between the dynamos and the turbines are designed so that they hold firmly under normal conditions, but when there is a dangerous overload, they slip, and so prevent any damage to the apparatus.

Mounted on pedestals, are circuit breakers, voltmeters, ammeters and horn lightning arresters for each generating unit, and the principal apparatus for regulating, starting and measuring are on a main switchboard. As usual in the Thury series system, the current is kept constant, and the voltage and speed vary with the load. The regulation is effected by means of an electro-magnetic governor which acts through an auxiliary motor so as to vary the flow of water to the turbines.

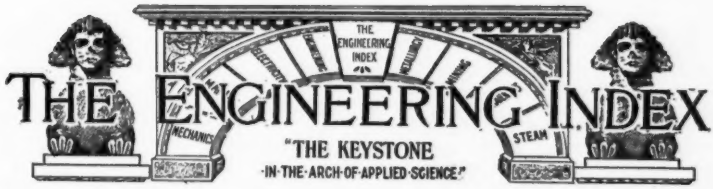
The overhead line conductors consist of two copper wires, each 9 millimeters (.35 inch) in diameter, with triple-petticoated porcelain insulators. Wooden poles are employed for most of the line, while for the remaining part the iron masts of a polyphase line are made use of. The underground part of the line consists of two cables, each having a section of 75 square millimeters (.12 square inch). They are composed of 19 stranded wires with paper insulation, and have double lead sheathing and iron armoring with tarred linen covering.

The resistance of the overhead line is 98 ohms, and that of the underground cable 2 ohms, so that the potential drop is 7,500 volts, and the energy loss 562 kilowatts, corresponding to 13 per cent. of the energy available at the terminals of the generators.

The first receiving station at Vaulx en Velin is equipped with three motors, fed by the line current, of 720 horse power each, and each driving a three-phase dynamo. The latter are connected with the three-phase distribution network of the Société Grénobloise, so that they can feed into this network, or can take current from the network and operate as synchronous motors, when they will drive the direct-current machines as dynamos and help supply the second receiving station in the center of the town.

The latter station has five line-current motors, which are coupled to direct-current, 520-kilowatt dynamos, which feed the street-railway system, at 600 volts. All the motors at the receiving stations are alike, and have the same general construction as the dynamos at the generating station.

The system is well provided with lightning arresters, and great care has been taken with the insulation, porcelain being freely used at the stations, where there is also asphalt flooring about the high-tension machines. Although the earth return has not been used in this installation, it might be employed to advantage under certain circumstances, and a scheme for its use has been devised. This transmission plant, which went into operation last April, has proved very satisfactory, and shows how well the system has been worked out, and with what security the high-tension, direct current can now be employed.



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Arched Structures. Brief review of old methods and illustrations of modern arches used for bridges and railroad structures. 1200 w. Ry & Loc Engng—Dec., 1906. No. 80869 C.

Guatemala.

Bridges and Viaducts on the Guatemala Ry. Outlines the extension work in progress on this railway, and gives a comparison of the designs submitted for bridges and viaducts with estimates of quantities and cost. Ills. 3000 w. Eng Rec—Dec. 8, 1906. No. 80911.

Newtown Creek.

The Erection of the Newtown Creek Bridge. Illustrated description of a bridge consisting of two approaches connected by a two-leaf Scherzer draw span of about 150 ft. clear opening. 600 w. Eng Rec—Dec. 15, 1906. No. 80992.

We supply copies of these articles. See page 838.

North Platte.

The North Platte River Bridge of the Union Pacific. Illustrates and describes the third bridge built at this point, briefly describing the two previous structures. The new bridge is a single-track structure of 40 spans. 900 w. R R Gaz—Dec. 14, 1906. No. 80966.

Quebec.

Notes on the Fabrication of the Quebec Bridge. An account of work where great perfection must be attained and verified. 2000 w. Eng Rec—Dec. 15, 1906. No. 80996.

The Anchor Arms of the Quebec Bridge. Illustrates and describes important features in the design of the south anchor arm, completed this last summer. 2500 w. Eng Rec—Dec. 1, 1906. No. 80815.

Adjustable Connection of Anchor-Arm Lateral System, Quebec Bridge. Illustrates and describes the adjustable connection of the lateral system in this arm. 1600 w. Eng Rec—Dec. 29, 1906. No. 81311.

South Bend Ry.

Recent Bridge Structures on the South Bend & Southern Michigan Railway. Illustrates and describes types built on an interurban railway from South Bend, Ind., to St. Joseph, Mich. 1200 w. St Ry Jour—Dec. 15, 1906. No. 81041.

CONSTRUCTION.

Caissons.

Righting a Capsized Lighthouse Caisson. Stuart Stevens Scott. An illustrated account of an engineering feat in Chesapeake Bay in connection with the foundation work for the "Baltimore Light." 1000 w. Sci Am—Dec. 15, 1906. No. 80973.

Cofferdams.

A Plan for Building Cofferdams for River Piers. C. P. Howard. Describes a breakwater or "current deadener" used with success in constructing piers of bridges in running streams where cofferdams are necessary. Ills. 1200 w. Eng News—Nov. 29, 1906. No. 80768.

Collapse.

The Collapse of the Bixby Hotel at Long Beach, Cal., on Nov. 9. H. Hawgood. An illustrated report of this disaster, with extracts from the testimony before the coroner's jury. Also editorial. 4500 w. Eng News—Nov. 29, 1906. No. 80767.

Concrete.

Practical Hints for Concrete Constructors. W. J. Douglas. Discusses methods of design and supervision necessary to attain first class work. 12000 w. Eng News—Dec. 20, 1906. No. 81078.

Treatment of Concrete for Residential Purposes. Albert Moyer. Suggestions for obtaining the best results. 3500 w. Cement Age—Dec., 1906. No. 80948.

Concrete Blocks.

Concrete Building Block Walls. Noyes F. Palmer. Discusses methods used in successful concrete building block construction. Ills. 2200 w. Cement Age—Dec., 1906. No. 80949.

Dams.

The Cataract Dam, Sydney, New South Wales. L. A. B. Wade. An illustrated description of the largest dam in Australia with an account of the discharge volume of flood water over it during construction. 700 w. Eng News—Dec. 6, 1906. No. 80843.

Factory.

The Bush Terminal Company Factory No. 2. Brief illustrated description of the construction of this fireproof factory in Brooklyn, N. Y. 1800 w. Eng Rec—Dec. 1, 1906. No. 80817.

Foundations.

Special Foundation Methods for a Small but Lofty Office Building. Describes the foundation work for an office building at No. 1 Wall St., New York, explaining the conditions of the site. 2500 w. Eng Rec—Dec. 1, 1906. No. 80816.

The Substructure of the West Street Building, New York. An illustrated description of the construction of foundations for a 23-story steel-cage building, describing the site which is within 300 ft. of the bulkhead line of the North River, and giving information of much interest. 3000 w. Eng Rec—Dec. 29, 1906. No. 81307.

Freezing Process.

The Freezing Process in the Battery Tunnel, New York. Gives an explanation of the method planned to be used in cases where alterations were required necessitating the removal of the upper segments of the lining. Ills. 3000 w. Eng Rec—Dec. 15, 1906. No. 80991.

Lighthouse.

Lighthouse Construction in the Philippines. Spencer Cosby. Explains the conditions in those islands, illustrating and describing the designs and work of the Spaniards, and the changes introduced by Americans, especially the use of concrete and reinforced concrete. Plates. 4500 w. Pro Am Soc of Civ Engrs—Nov., 1906. No. 80934 E.

Office Buildings.

See Mechanical Engineering, Power and Transmission.

Reinforced Concrete.

Evolution of Reinforced Concrete in Germany. O. Kohlmorgen. A review of the development of this form of construction in Germany. 1500 w. Am Archt—Dec. 15, 1906. No. 81009.

We supply copies of these articles. See page 838.

Reinforced Concrete Construction. Walter Mueller. Discusses the Ransome system and its effect upon the Portland cement industry, and describes other systems. Ills. 1600 w. Cement Age—Dec., 1906. No. 80946.

Reinforced Concrete in a Canadian Machine Shop Plant. Illustration and description of an application at Toronto, Canada. 700 w. Eng News—Dec. 20, 1906. No. 81077.

The McGraw Building. An illustrated detailed description of an example of reinforced concrete construction on West 39th St., New York City. 2000 w. Archts & Bldrs' Mag—Dec., 1906. No. 80952 C.

Roofs.

Saw Tooth Skylight in Factory Roof Construction. Discussion of paper by Fred S. Hines. Ills. Also discussion of paper on the same subject by Knight C. Richmond. 5400 w. Pro Am Soc of Mech Engrs—Dec., 1906. No. 81066.

Stables.

Revolutionary Ideas in Stable Architecture. An illustrated description of a fine stable building and auction mart in New York city. A steel skeleton structure having many innovations and improvements of interest. 1200 w. Archts & Bldrs' Mag—Dec., 1906. No. 80953 C.

Steam Shovel Work.

Cost of Steam Shovel Work. John C. Sesser. Reprinted from Bul. 81, Nov., 1906, Am. Ry. Engng. & Main. of Way Assn. Reports of the Big Shoal and Little Shoal cut-off work, on the Burlington System. 2200 w. R R Gaz—Dec. 21, 1906. No. 81211.

Steelwork.

The Steelwork of the City Investing Company's Building, New York. Notes concerning the steel superstructure of this building. Plans. 2500 w. Eng Rec—Dec. 1, 1906. No. 80819.

Tunnels.

Driving the Gunnison Tunnel. Illustrated description of the driving of this tunnel for the purpose of diverting the waters of the Gunnison river into the Uncompahgre valley in Southwestern Colorado. 1800 w. Min Rept—Dec. 20, 1906. No. 81225.

The Gunnison Tunnel of the Uncompahgre Irrigation Project. M. G. Doll. Illustrates and describes the methods and progress made in driving a tunnel nearly six miles in length through material ranging from soft mud to hard rock, nearly five miles being driven from two headings without intermediate shafts. 2700 w. Compressed Air—Dec., 1906. No. 80955.

The Construction of the Pennsylvania R. R. Tunnels under the North River at New York City. James Forgie. An Illustrated detailed description of this great engineering feat. A second paper will record the methods of working in the kind of ground encountered, especially the soft river mud. Also editorial. 11500 w. Eng News—Dec. 13, 1906. No. 80968.

The Pennsylvania Tunnels Under the North River. An interesting illustrated description of the tunnels and methods of construction, the care given the men, the plant, etc. 4500 w. R R Gaz—Dec. 28, 1906. No. 81304.

The Romance of Tunnel Building. Arthur B. Reeve. An illustrated account of the 16 subaqueous tunnels built and building under the rivers around New York City, the dangers and difficulties, and methods of construction. 5600 w. World's Work—Dec., 1906. No 80851 C.

Tunnel Lining Work in the Far West. An illustrated description of the relining of the Hodges Pass tunnel on the Oregon Short Line Ry. 1400 w. Eng News—Dec. 6, 1906. No. 80845.

MATERIALS OF CONSTRUCTION.

Adhesion.

The Adhesion of Mortar and Concrete. R. Feret. Gives facts relating to normal and to tangential adhesion, and things that affect the adhesion to different materials. 1400 w. Cement—Nov., 1906. No. 80759 C.

Cement.

The Industrial Relations of the American Cement Industry. Edwin C. Eckel. Demonstrating that its phenomenal growth has not yet overtaken the normal demand, and that natural conditions while fostering large units in manufacturing, prohibit complete centralization or trust formation. 2500 w. Engineering Magazine—Jan., 1907. No. 81190 B.

Portland Cement as Manufactured at Fordwick, Virginia. R. B. Colton. Describes the manufacture, the materials used, the qualities, etc. 1600 w. Yale Sci M—Dec., 1906. No. 81057 C.

The Aging of Portland Cement. H. Spencer Conover. Discussion of why it becomes quick setting on aging. Also views of other experts. 4000 w. Cement Age—Dec., 1906. No. 80947.

Concrete.

The Fatigue of Concrete. J. L. Van Ornum. An illustrated report of research work including both concrete blocks in compression and reinforced concrete subjected to transverse loading. 8000 w. Pro Am Soc of Civ Engrs—Dec., 1906. No. 81299 E.

The Value of Brick in Concrete. Loren E. Hunt. Gives details of test work and results obtained with broken brick as a substitute for rock in concrete. 3000 w. Cal Jour of Tech—Dec., 1906. No. 81202.

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Plaster.

The Périn System of Manufacturing Plaster (Procédé de Fabrication du Plâtre, Système L. Périn). A. Dumas. Illustrated description of Périn rotary furnace and other details, and general discussion of the manufacture of plaster from gypsum. 2500 w. Génie Civil—Dec. 1, 1906. No. 81135 D.

Manufacture of Plaster of Paris. C. O. Bartlett. Illustrates and describes methods and machinery used whereby gypsum deposits may be easily utilized. 1500 w. Eng & Min Jour—Dec. 8, 1906. No. 80886.

Sand Blast.

Testing of Building Materials by the Sand-Blast Apparatus. H. Burcharts. Illustrates and describes the apparatus used and its effect. 1500 w. Engng—Nov. 30, 1906. No. 80925 A.

Structural Steel.

The New Structural Shapes of the Bethlehem Steel Co. Gives illustrated description of new shapes to be rolled, showing their range of application as compared with standard sections. 1800 w. Eng Rec—Dec. 22, 1906. No. 81229.

MUNICIPAL.

Abattoirs.

The Sanitary Features of Markets and Abattoirs. William Paul Gerhard. A series of articles discussing briefly the buildings devoted to food supplies for large cities, especially their interior planning and construction, equipment, and sanitary arrangement. Ills. 1400 w. Am Archt—Dec. 15, 1906. Serial. 1st part. No. 81008.

Refuse.

Specifications for Refuse Destructor, Borough of Richmond, New York City. Gives the most important portions of specifications on the lines of recent British practice, for a refuse destructor designed to produce heat for lighting or power purposes. Plans. 2500 w. Eng News—Dec. 6, 1906. No. 80846.

Sewage Disposal.

Advance in Sewage Purification. Alexander Potter. From a paper before the League of Am. Municipalities. Considers legislative enactments and practice in America. 3000 w. Munic Engng—Dec., 1906. No. 80951 C.

The Sewage Disposal Problem of Metropolitan New York and New Jersey. Editorial on proper disposal of sewage in this thickly settled district, describing the conditions and the difficulties. 3000 w. Eng News—Dec. 20, 1906. No. 81082.

The Maintenance of Intermittent Sewage Filters in Winter. Extracts from an interesting discussion at the meeting of the Sanitary Section of the Boston Soc. of Civ. Engrs., on Dec. 5, 1906. 1200 w. Eng News—Dec. 13, 1906. No. 80971.

Septic Tanks at Birmingham. An illustrated description of the county sewerage system serving this city of Alabama and the surrounding territory, giving cost and other data. 2000 w. Munic Jour & Engr—Dec. 5, 1906. No. 80868 C.

Sewers.

Notes on the Sewers in Manhattan Borough, New York City. Outlines the general plan and the materials used, the repairs and maintenance. 1800 w. Eng Rec—Dec. 15, 1906. No. 80994.

Rainfall, and Run-Off in Storm-Water Sewers. Charles Emerson Gregory. Aims to bring together matter contained in previous discussions and to propose a more rational method of solution. 9200 w. Pro Am Soc of Civ Engrs—Nov., 1906. No. 80935 E.

Sewerage and Storm-Water Drainage in Johannesburg. D. C. Leitch, and G. S. Burt Andrews. A brief review of the principal features of the work now in progress. 5 plates. 15600 w. Jour S African Assn of Engrs—Oct., 1906. No. 80922 F.

Town Extensions.

The Planning and Control of Town Extensions in Germany. T. C. Horsfall. An interesting account of the excellent result due to power given to the municipal authorities. 3000 w. Eng News—Dec. 20, 1906. No. 81079.

WATER SUPPLY.

Air-Lift.

Emergency Air-Lift Equipment for Deep Wells, Marion City, (O.) Water Co. Edward H. Cowan. Illustrates and describes an ingenious but simple piece of engineering work. 800 w. Eng News—Dec. 13, 1906. No. 80969.

Brockton.

The New Water Supply of the City of Brockton. Charles R. Felton. An account of the new supply from Silver Lake, the trouble with organisms affecting the water, and the construction of the works. Ills. Also discussion. 5000 w. Jour N Eng W-Wks Assn—Dec., 1906. No. 81095 F.

Filtration.

Contractors' Plant and Methods on the Construction of the Pittsburg Filtration Plant. Robert Swan. Illustrated detailed description of the construction of a plant covering an area of about 125 acres, and having a daily filtering capacity of 3,000,000 gallons. 4000 w. Eng News—Nov. 29, 1906. No. 80769.

Copper Sulphate for Water Filtration. Dr. Adolphe Kemna. Abstract of a paper read before the Assn. of Water Engrs. On the destruction of organisms that make the water offensive, giving results obtained with copper sulphate. General discussion. 8000 w. Jour Gas Lgt—Dec. 18, 1906. No. 81256 A.

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Development of Mechanical Filtration. F. B. Leopold. Brief review of the history of filtration of public supplies. 3500 w. Fire & Water—Dec. 29, 1906. No. 81317.

The Pittsburgh Filtration Plant. Illustrated detailed description of the slow-sand filtration plant, for treating the water supply, which is under construction. 5400 w. Eng Rec—Dec. 8, 1906. Serial. 1st part. No. 80908.

Ground Water.

Fluorescein in the Study of Underground Waters. An account of the use of this coal-tar product for the study of conditions in subterranean basins. Notes from a paper by R. B. Dole, published by the U. S. Geol. Survey. 2200 w. Eng Rec—Dec. 29, 1906. No. 81312.

High Pressure.

The Diminution of the Diameter of High Pressure Water Conduits (Die Verjüngung der Rohrweite bei Hochdruckleitungen). Philipp Forchheimer. Brief mathematical discussion of economical diameters and thicknesses of pipes at places where the pressures are different. Diagrams. 600 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81153 D.

Irrigation.

A Remarkable Combination of State and Corporate Action in a Wyoming Irrigation System. An outline of a novel plan for the development of irrigation for a portion of the Shoshone Indian Reservation in Wyoming, opened for settlement June 15, 1906. 1000 w. Eng News —Dec. 20, 1906. No. 81080.

New Orleans.

The New Orleans Water Works. George G. Earl. From a paper before the Am. Soc. of Munic. Imp. Describes the water purification plants and distribution system proposed for this city. 3500 w. Munic Engng—Dec., 1906. No. 80950 C.

Penstock.

The Second Penstock of the Kubel Hydro-Electric Plant (Die Zweite Druckleitung des Elektrizitätswerkes Kubel). L. Kürsteiner. Well illustrated description of steel pipe, 63 inches inside diameter and 981 feet long, siphoning out of the reservoir and crossing a stream by an arch; near St. Gall. 1200 w. Schweiz Bauzeitung—Nov. 3, 1906. No. 81101 B.

Pitometer.

The Pitometer, J. D. Underwood. Deals with the use of the pitometer for locating leakage or theft of water from the mains and service pipes of a waterworks system. Ills. Also discussion. 4000 w. Pro Engrs Soc of W Penn—Dec., 1906. No. 81061 D.

Pond Water.

A Remarkable Experience with Pond Water. Notes from a paper by Herbert B. Baldwin and George C. Whipple, presented at the convention of the American Public Health Assn., concerning the investigation made of the cause of the sudden destruction of fish in Weequahic Lake, Newark, N. J. 2500 w. Eng Rec —Dec. 8, 1906. No. 80909.

Protection.

On the Protection of Public Water Supplies from Pollution During the Construction, Maintenance, and Operation of Railroads, with Special Reference to the Water Supply of Seattle, Washington; Together with Criticisms of the Present Methods of Water Supply and Sewerage of Railway Trains. William T. Sedgwick. 22800 w. Jour N Eng W-Wks Assn—Dec., 1906. No. 81096 F.

Prevention of the Bacterial Contamination of Streams and Oyster Beds. W. Pollard Digby and H. C. H. Shenton. Aims to show that methods of sewage treatment have been recently devised by which the dangerous qualities of sewage may be wholly eliminated. Plate. 10300 w. Soc of Engrs—Dec. 3, 1906. No. 80954 N.

The Washington Typhoid Situation and How the Baltimore Water Department Has Protected its Supply Without Filtration. Alfred M. Quick. An account of the work done, and of the investigations which tend to show that infection was not from the water supply. 2500 w. Eng News—Nov. 29, 1906. No. 80770.

Purification.

The Removal of Iron from the Water Supply of Reading, Mass. Describes the methods adopted for the purification of water containing iron and also vegetable matter. 2500 w. Eng Rec—Dec. 1, 1906. No. 80818.

See also Mechanical Engineering, Steam Engineering.

Standpipes.

Reinforced Concrete Standpipes. Illustrates and describes standpipes built at Fort Revere, Mass., Milford, O., and Attleboro, Mass., showing them to be more durable and cheaper than steel. 2000 w. Munic Jour & Engr—Dec. 5, 1906. No. 80867 C.

Submerged Main.

Laying a Submerged Water Main in the River South Esk, at Montrose. Herbert Hall. Describes the method of laying. 1200 w. Jour Gas Lgt—Dec. 18, 1906. No. 81257 A.

Water Race.

See Mining and Metallurgy, Mining.

WATERWAYS AND HARBORS.

Atchafalaya River.

The Atchafalaya River: Some of Its Peculiar Physical Characteristics. Discussion of the paper by J. A. Ockerson. 5800 w. Pro Am Soc of Civ Engrs—Dec., 1906. No. 81301 E.

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Canals.

Canals v. Railways. Ivan C. Barling. Abstracted from presidential address before the Newcastle Students' Assn. of the Inst. of Civ. Engrs. On the improvements needed to increase the efficiency of canals, especially considering British canals. 2500 w. Ir & Coal Trds Rev—Nov. 30, 1906. No. 80931 A.

Colombo.

Colombo Harbor. An illustrated description of the harbor works at Colombo, in Ceylon, now nearing completion. They have cost about 1¾ millions sterling, and occupied over 30 years in construction. 5500 w. Engng—Dec. 7, 1906. No. 81025 A.

Colorado River.

The Reinforced Concrete and Steel Headgates for the Imperial Canal, Colorado River. James D. Schuyler. Illustrates and describes these large headgates, their construction and operation. 1000 w. Eng News—Dec. 27, 1906. No. 81284.

Controlling the Colorado River and Salton Sea. Illustrations and diagrams showing the situation and present conditions, describing some of the measures aiming to return the river to its proper channel. 2000 w. Sci Am—Dec. 22, 1906. No. 81085.

Closing the Break of the Colorado River into the Salton Sink, Southern California. H. T. Cory. An account of this disaster while diverting a part of the water of this river for irrigation, and of the attempts made to restore the river to its old bed. Ills. 5500 w. Eng News—Dec. 27, 1906. No. 81283.

Connecticut Run-Off.

Twenty Years Run-Off. at Holyoke, Mass., of the Connecticut River. Clemens Herschel. Gives a record of 20 years' weir gaugings made by the writer. 1200 w. Pro Am Soc of Civ Engrs—Nov., 1906. No. 80936 E.

Devon-Cornwall.

Proposed Harbor of Refuge Inquiry. Condensed version of the report of Sir Wm. Matthews, dealing with the proposal to construct a harbor of refuge in some locality on the North coasts of Devon and Cornwall. 3500 w. Engr, Lond—Dec. 7, 1906. Serial. 1st part. No. 81034 A.

Panama.

President Roosevelt's Special Message on the Panama Canal. Condensed from the original message transmitted to Congress Dec. 17, 1906. Ills. 5500 w. Eng News—Dec. 20, 1906. No. 81083.

Safeguards for the Panama Canal Locks. An outline of some of the devices that could be used for the protection of the locks. 1500 w. Sci Am—Dec. 8, 1906. No. 80879.

Passaic Control.

Flood Control and Conservation of Water Applied to Passaic River. Morris R. Sherrerd. Gives an outline of the possibilities for controlling this river of New Jersey, based on investigations recently made. 2500 w. Eng Rec—Dec. 1, 1906. No. 80820.

Salton Sea.

The Possibilities of Salton Sea. Charles Alma Byers. An illustrated article considering the results that would follow the abandoning of effort to restore the Colorado River to its old channel, and discussing the irrigation projects which led to the disaster. 2800 w. Pop Sci M—Jan., 1907. No. 81261 C.

San Diego.

The Harbor of San Diego, California. Clarence E. Edwards. Information and illustrated description of this fine harbor on the Pacific Coast. 1400 w. Marine Rev—Dec. 20, 1906. No. 81219.

Terminal.

Steamship Terminal with Concrete Pile Piers at Brunswick, Ga.; Atlantic & Birmingham Ry. An illustrated detailed description of the plans for the new water and rail terminals which provide for 5 freight or steamship piers, a coal pier, a lumber yard, freight sheds and other structures. 1600 w. Eng News—Dec. 20, 1906. No. 81081.

Waterways Commission.

The Work of the International Waterways Commission. J. A. Macdonald. Information concerning cases dealt with affecting waters on the boundary between the United States and Canada, and the spirit of fairness shown. 1500 w. Eng News—Dec. 13, 1906. No. 80970.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Aerial Cable Construction for Telephone Exchanges. C. W. Burkett. Outlines practice in aerial cable construction for telephone exchanges. 3500 w. Wis Engr—Dec., 1906. No. 81275 D.

Exchange

The Hamilton, Ohio, New Telephone Exchange. J. E. Peavey. Brief illustrated description of a model manually operated telephone exchange recently put into service. 900 w. Elec Rev, N. Y.—Dec. 15, 1906. No. 80982.

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A Protective Device Against Accidental Sparking in Wireless Tele-Mechanisms. E. Branly. Describes the device and its use. 1000 w. Elect'n Lond—Dec. 7, 1906. No. 81013 A.

The Generation and Use of Undamped High-Frequency Oscillations in Radio-Telegraphy (Ueber die Erzeugung und Verwendung Ungedämpfter Hochfrequenz Schwingungen in der Drahtlosen Nachrichten Uebertragung). W. Hahnemann. An illustrated description of an arc transmitter with large hollow copper anode filled with water, for cooling, and carbon cathode. Also discussion of relative advantages of undamped and damped oscillations. 1800 w. Elektrotech Zeitschr—Nov. 22, 1906. No. 81157 B.

Radio-Telegraphy and the Telefunken System. Describing the Telefunken system of the Gessellschaft für Drahtlose Telegraphie, of Berlin. Diagrams. 3500 w. Engng—Dec., 14, 1905. Serial. 1st part. No. 81246 A.

Recent Methods in Wireless Telegraphy. T. C. McKay. Describes new detectors which have aided the advance in wireless telegraphy, and explains the general arrangement for sending and receiving currents. Diagrams. 4000 w. Cal Jour of Tech—Dec., 1906. No. 81204.

The Poulsen Selection System of Wireless Telegraphy. A. Frederick Collins. Information concerning a new system which employs an arc transmitter. Ills. 1800 w. Sci Am—Dec. 15, 1906. No. 80976.

Wireless Telegraphy as a Safeguard in Railway Service. Dr. Eugen Nesper. Abstract translation from *Elektrotechnische Zeitschrift*. An account of experiments made in Germany. 900 w. Elect'n, Lond—Dec. 7, 1906. No 81012 A.

On a Method of Producing Continuous High-Frequency Electric Oscillations. S. G. Brown. Describes briefly methods employed by the writer for the continuous production of high-frequency oscillations, in wireless telegraphy. 800 w. Elect'n, Lond—Nov. 23, 1906. No. 80829 A.

The Measurement of Received Energy at Wireless Stations. Greenleaf W. Pickard. Explains a simple method developed by the writer for measuring the energy received at each discharge of the distant station, the only limitation being the sensitiveness of the detector employed. 1300 w. Elec Rev N Y—Dec. 15, 1906. No. 80983.

The Influence of the "Counterbalance" on the Damping of the Aerial in Radio-Telegraphy (Ueber den Einfluss des Gegengewichtes auf die Dämpfung des Luftdrahtes in der Drahtlosen Telegraphie). Dr. Walther Burstyn. Mathematical discussion of the influence of a capacity at the lower end of an aerial which is not grounded. 1000 w. Elektrotech Zeitschr—Nov. 29, 1905. No. 81162 B.

DISTRIBUTION.

Balancers.

Static Balancers for 3-Wire Distribution Systems. An illustrated explanation of the principle of this apparatus. 2500 w. Mech Engr—Dec. 1, 1906. No. 80915 A.

Cable Heating.

The Loading of Multiple-Conductor Cables, Laid Underground, With Reference to Heating (Die Belastung von Verseilten, im Erdboden Verlegten Mehrleiter-Kabeln, mit Rüchsicht auf Erwärmung). J. Teichmüller und P. Humann. Record of experiments on high-voltage, polyphase cables, with discussion of results. Tables and diagrams. 2000 w. Elektrotech Zeitschr—Nov. 22, 1906. No. 81155 B.

Clyde Valley.

The Clyde Valley Power Company. Information showing the consumers supplied by this company with illustrated description of the line construction. 1800 w. Elec Engr, Lond—Dec. 14, 1906. No. 81238 A.

Cost.

Cheapened Methods of Electrical Distribution. J. H. C. Brooking. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Briefly considers the methods recently used for lowering the capital cost. Also discussion. 4000 w. Elec Engr, Lond—Dec. 21, 1906. No. 81334 A.

Losses.

Distribution Losses. John C. Potter. An account of methods used in determining the distribution losses of the A. C. lighting system of Milwaukee. Diagrams. 2500 w. Wis Engr—Dec., 1906. No. 81277 D.

Mining Plant.

The Reduction of Mining Costs by Electric Operation. Dr. Alfred Gradenwitz. An illustrated description of a novel Continental installation using a buffer storage battery with polyphase transmission. 1500 w. Engineering Magazine—Jan., 1907. No. 81193 B.

Power Factor.

The Physical Meaning of Power Factor and the Significance of a Power Factor Less Than Unity Without Phase Difference. Albert F. Ganz. Defines the power factor and considers its physical meaning in a circuit with sinusoidal electromotive force and current, wave forms which are not sinusoidal, and pulsating continuous currents. 3500 w. Jour Fr Inst—Dec., 1906. No. 80944 D.

Protective Appliances.

The Sources of Danger in Alternating

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Current Plants and Some Modern Protective Appliances (Die Gefahrquellen in Elektrischem Wechselstromanlagen und einige Moderne Schutzvorrichtungen zur Abwendung der Gefahren). Hermann Zipp. Discussion of electric shock and its causes, and illustrated description of insulators, lightning arresters and other protective apparatus. 5500 w. Zeitschr d Ver Deutscher Ing—Nov. 24, 1905. No. 81147 D.

Railway Feeding.

Advantages and Disadvantages of Feeding Tramway Systems in Isolated Zones as Compared with Closed Networks. Report of M. G. Rasch on the replies received to questions sent out concerning the advantages and disadvantages of feeding by open or closed circuits. 4000 w. Elect'n, Lond—Nov. 23, 1906. No. 80833 A.

Switchboards.

Recent Design in Direct-Current Switchboards. Edward Schildhauer. Illustrates and describes some of the recent practice of the Chicago Edison Company in direct-current switchboard design. 900 w. Elec Wld—Dec. 1, 1906. No. 80807.

ELECTRO-CHEMISTRY.

Aluminum Battery.

Aluminum Cells (Ueber Aluminiumzellen). Dr. Max Büttner. Account of tests of storage battery used for train lighting in Prussia having aluminum and iron plates and ammonium carbonate electrolyte. Diagrams. 3500 w. Zeitschr f Elektrochem—Nov. 2, 1906. No. 81122 G.

Electrolysis.

Independent Stirrer for Electrolysis. E. L. Larrison. An inexpensive substitute for rotating cathodes is described and the method explained. 2200 w. Eng & Min Jour—Dec. 22, 1906. No. 81215.

Electro-Metallurgy.

Electro-Metallurgy in 1905 and the First Half of 1906 (Die Electro-Metallurgie im Jahre 1905 und im Ersten Halbjahre 1906). Dr. Franz Peters. Illustrated comprehensive general review. Serial. 9 parts. 33000 w. Glückauf—Oct. 20, 27; Nov. 3, 10, 17, 24; Dec. 1, 8 and 15, 1906. No. 81107 each D.

Electric Furnace Methods of Iron and Steel Production. John B. C. Kershaw. Illustrated description of various electric furnaces and processes. 2500 w. Ir Trd Rev—Nov. 29, 1906. No. 80753.

The Present State of the Electro-Metallurgy of Iron and Steel (L'Etat Actuel de l'Electrosidérurgie). Léon Guillet. Well illustrated and comprehensive description of electric plants, furnaces and processes, Serial. 1st part. 1 plate. 3500 w. Génie Civil—Dec. 8, 1906. No. 81137 D.

The Electric Furnace and Its Applications to the Metallurgy of Iron and Steel. R. S. Hutton. Read before the Sheffield Soc. of Engrs. & Met. Discusses recent developments to be considered in connection with power generation, the applications of electric power to industries, and some recent types of electric furnaces. 6000 w. Engng—Dec. 7, 1906. No. 81028 A.

The Electrothermal Metallurgy of Iron. Major E. Stassano. Discusses the principles upon which the electrothermal process depends and gives an illustrated description of the rotating furnace designed by the writer. 7000 w. Sci Am Sup—Dec. 22, 1906. No. 81089.

Hypochlorites.

The Hermite Electrolytic Process at Poplar. Charles V. Biggs. Read before the Faraday Soc. A contribution to the facts available on the subject of the electrolytic production of hypochlorites. 2000 w. Elec Engr, Lond—Nov. 23, 1906. No. 80827 A.

Nickel Plate Waste.

Experiments for Saving Copper and Nickel from the Waste Pieces of Nickel Plated Sheets (Ueber Einige Versuche zur Gewinnung von Kupfer und Nickel aus Abfällen Nickelplattierter Bleche). Carl Richter. Description of electrolytic process. 2500 w. Elektrochem Zeitschr—Dec., 1906. No. 81120 G.

ELECTRO-PHYSICS.

Compass Variations.

The Influence of the Surface Currents Flowing Through Iron Ships' Hulls on the Magnetic Compass (Die Einwirkung der Durch den Eisernen Schiffskörper Fliessenden Flachenströme auf das Kompassfeld). C. Arldt. Discussion of formulæ, with experimental determination. Tables and diagrams. 1800 w. Elektrotech Zeitschr—Nov. 22, 1906. No. 81156 B.

Electro-Magnetism.

Electro-Magnetism. Roger Atkinson. An explanation of the magnetic field that surrounds a single wire or conductor carrying a current. Diagrams. 700 w. Ry & Loc Engng—Dec., 1906. No. 80871 C.

Induction Coils.

The Design of Induction Coils. William O. Eddy and Melville Eastham. Considers the type of coils employing open cores of iron wire, giving facts and suggestions useful to designers and users of these instruments. 7000 w. Elec Wld—Dec. 22, 1906. No. 81218.

Interrupter.

How to Construct an Independent Interrupter. A. Frederick Collins. Illustrates and describes a type embodying all the improvements of the double-spring interrupter, stating its advantages, and

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explaining the operation. 1600 w. Sci Am Sup—Dec. 15, 1906. No. 80979.

Magnetic Alloys.

Experiments on the Heusler Magnetic Alloys. K. E. Guthe and L. W. Austin. Gives the main results of the work of Dr. Heusler and his associates in producing from non-magnetic metals, alloys which approach iron in their magnetic properties. 2400 w. Elect'n, Lond—Nov. 23, 1906. Serial. 1st part. No. 80832 A.

Waves.

Analysis of Alternating-Current Waves. S. A. Hazeltine. Describes methods for treating electric waves graphically, with the object of resolving waves into their harmonics and the determination of the effective voltage and current and the mean power directly from the wave-forms. 1500 w. Stevens Ind—Oct., 1906. No. 81093 D.

Discussion on "The Effect of Iron in Distorting Alternating Current Wave-Form" at New York, September 28, 1906. Discussion of the paper presented by Frederick Bedell and Albert B. Tuttle. 6500 w. Pro Am Inst of Elec Engrs—Nov., 1906. No. 81063 D.

GENERATING STATIONS.

Armatures.

Armature Reaction in Polyphase Alternators. L. A. Herdt. Outlines an experimental method for the determination of the regulation of alternators under load. Diagrams. 2000 w. Elec Rev, N Y—Dec. 1, 1906. No. 80787.

Chicago.

A 100,000-Kilowatt Steam-Turbine Station. J. C. Thorpe. Illustrated detailed description of the Fisk Street station, Chicago, which has the largest steam-generating plant yet projected. 5000 w. Power—Dec., 1906. No. 80997 C.

Commutation.

Some Phenomena of Commutation. Prof. F. G. Baily and W. S. H. Cleghorne. Abstract of a paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Deals with the contact resistance of the brush, the value of the brush current, the currents in the short-circuited coils and the E. M. F. between the segment and the trailing edge of the brush. 4500 w. Elect'n, Lond—Nov. 23, 1906. Serial. 1st part. No. 80830 A.

Dynamos.

Recent Advances in the Construction of Constant Current Dynamos. Dr. E. Rosenbery. Abstracted from the *Elektrotechnische Zeitschrift*. An illustrated account of recent developments. 1200 w. Elect'n, Lond—Dec. 21, 1906. No. 81357 A.

A Simple Experimental Dynamo. Paul H. Woodruff. Describes the construction, illustrating details. 1200 w. Sci Am—Dec. 29, 1906. No. 81293.

A New Type of Continuous-Current Dynamo-Electric Machine with Commutating Poles. V. A. Fynn. Describes a new type proposed by the author, stating its advantages. Considers it well suited to meet the conditions obtaining in turbo-generators. 2000 w. Elect'n, Lond—Nov. 30, 1906. No. 80914 A.

Alternating-Current Machines. An explanation of the elementary principles of the modern alternator and alternating-current motor. Ills. 3000 w. Prac Engr—Nov. 23, 1906. Serial. 1st part. No. 80822 A.

Exciters.

The Operation and Care of Exciters. A. E. Buchenberg. Practical suggestions on how to detect and remedy exciter troubles. 1200 w. Engr, U S A—Dec. 15, 1906. No. 81052 C.

Finances.

The Revenues of Electric Stations in Large Cities and the Influence on Them of Furnishing Current to Railways (Die Erträgnisse von Elektrizitätswerken in Grosseren Städten und Ihre Beeinflussung durch Stromlieferung für eine Bahn). G. Dettmar. Discussion of statistics of a large number of stations, and comparison with results from small stations, given in a previous article. Tables. 2500 w. Elektrotech Zeitschr—Nov. 29, 1906. No. 81160 B.

Hydro-Electric.

Hydro-Electric Developments at Huntingdon, Pa. Illustrates and describes two plants under construction by the Juniata Hydro-Electric Co., which will form part of an important electric transmission system. 3000 w. Elec Wld—Dec. 22. 1906. No. 81216.

Hydro-Electric Power Station at Wangen. Illustrated description of an high-tension installation erected along the course of the river Aare, in the Canton of Berne. 1800 w. Engr, Lond—Nov. 30, 1906. No. 80929 A.

North Wales Power Company. Illustrates and describes the first British hydro-electric power scheme. 2700 w. Elec Engr, Lond—Dec. 21, 1906. Serial. 1st part. No. 81333 A.

The Entraygues (France) Hydro-electric Plant. C. L. Durand. Illustrated description of a new station utilizing the power of mountain streams in the Alpine region, supplying current for Toulon and villages on the Mediterranean coast. 3000 w. Elec Rev, N Y—Dec. 8, 1906. No. 80891.

The Hydro-Electric Plant of the Belton Power Co. George Wrigley. Illustrated description of a generating plant on the Saluda River, S. C. 2200 w. Eng Rec—Dec. 15, 1906. No. 80993.

The Snowdon Hydro-Electric Installation of the North Wales Power and

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Traction Co., Ltd. Illustrates and describes the engineering features of this scheme. 3000 w. Elec Rev, Lond—Dec. 7, 1906. Serial. 1st part. No. 81024 A.

The Warriors Ridge Hydro-Electric Plant at Huntingdon, Pa. Illustrates and describes details of a combined hydraulic and steam plant of 8000 horse-power. 4000 w. Eng Rec—Dec. 22, 1906. No. 81228.

The Whitney Development on the Yadkin. Julian I. Miller. An illustrated account of an important hydro-electric project being carried out in North Carolina. 2000 w. Elec Rev, N Y—Dec. 29, 1906. No. 81305.

Paris.

The St. Denis Station of the Paris Electric Co. (L'Usine Electrique de la Société d'Electricité de Paris à Saint-Denis, Seine). G. Boëto. Illustrated description of station and its steam and electric equipment, including 5000-kilowatt turbo-alternators. 2 plates. Serial. 2 parts. 10000 w. Génie Civil—Nov. 17 and 24, 1906. No. 81132 each D.

Rotaries.

Rotary Converters v. Motor-Generators. Miles Walker. Abstract of paper and discussion before the Manchester Sec. of the Inst. of Elec. Engrs. A comparison of the advantages, considering the four types of apparatus at present in commercial use. 5500 w. Elect'n, Lond—Dec. 14, 1906. No. 81243 A.

Sydney, N. S. W.

Sydney Electrical Supply. An illustrated article giving the history of the City Council's undertaking. 4000 w. Aust Min Stand—Oct. 17 and 24, 1906. Serial. 2 parts. No. 80804 each B.

Turbo-Dynamos.

Steam Turbine Dynamos. A. G. Ellis. Discusses the advantages of the steam turbine as a prime mover, also reviews the limiting factors to the outfit, and the effect of increasing the speed. 4000 w. Mech Engr—Nov. 24, 1906. Serial. 1st part. No. 80826 A.

Waltham.

The New Power Plant for Railway and Lighting Service in Waltham, Mass. Illustrated description of a plant built to supply cheap power to railway lines and for power and lighting. Reinforced concrete is extensively used, and many features of interest introduced. 3500 w. St Ry Jour—Dec. 29, 1906. No. 81319.

LIGHTING.

Car Lighting.

The Vickers-Hall System of Train-Lighting. Illustrates and describes this system of electric lighting of trains. 2000 w. Engng—Dec. 14, 1906. No. 81250 A.

The Use of Storage Batteries in the Electric Lighting of Steam Passenger Equipment. J. R. Sloan. Describes the ways batteries are used in this service at present, and recent improvements introduced, giving specifications thought to represent the type of cell best suited to this work. Ills. 3000 w. Elec Rev, N Y—Dec. 8, 1906. No. 80890.

Clusters.

Incandescent-Lamp Clusters and Bowls. J. R. Cravath and V. R. Lansingh. Illustrates and describes various types, reporting tests made. 1500 w. Elec Wld—Dec. 1, 1906. No. 80806.

Metal Filaments.

Metallic Filaments for Electric Lamps. J. Swinburne, in *The London Times Engng. Sup.* Information in regard to the process invented by Dr. Hans Kuzel by which the most refractory metals can be made into filaments. 900 w. Sci Am Sup—Dec. 15, 1906. No. 80978.

The New Incandescent Electric Lamps. An interesting review of recent developments in these lamps, and the properties which give them value in therapeutics and the industries, as well as for lighting. 3500 w. Engr, Lond—Dec. 7, 1906. Serial. 1st part. No. 81030 A.

Experiments on Carbon, Osmium, and Tantalum Lamps. J. T. Morris. A report of experiments undertaken to ascertain how variation of voltage affects the candle-power and efficiency of certain recent types of filament lamps. 2700 w. Elect'n, Lond—Dec. 14, 1906. No. 81242 A.

Tests.

Tests of Incandescent Lamps. L. B. Spinney. A discussion of lamp efficiency, giving results of lamp tests. 1500 w. Elec Wld—Dec. 15, 1906. No. 81053.

Transformation.

Transformation of Electric Power into Light. Charles Proteus Steinmetz. Considers lighting by incandescence; selective radiation of solids; electroluminescence of vapors and gases; vacuum-tube illumination; the arc; and the arc as an illuminant. 2400 w. Pro Am Inst of Elec Engrs—Nov., 1906. No. 81062 D.

University of Pennsylvania.

A Noteworthy Example of Modern Illuminating Engineering. Illustrates and describes the artificial lighting of the engineering laboratories of the University of Pennsylvania. 800 w. Elec Rev, N Y—Dec. 29, 1906. No. 81306.

MEASUREMENT.

Gutta Percha.

The Temperature Coefficient of Gutta Percha (Ueber Temperatur-Koeffizienten von Gutta Percha). K. Winnertz. Experimental determination, showing that coefficient is not constant. Tables and curve. 800 w. Elektrotech Zeitschr—Nov. 29, 1906. No. 81161 B.

Materials.

Selection and Testing of Materials for

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Construction of Electric Machinery. Prof. J. Epstein. Discusses methods of testing the materials and the completed machines, and related matters of interest. Ills. 11700 w. Inst of Elec Engrs—Nov. 22, 1906. No. 80905 N.

Meters.

The Accuracy of Meters. H. J. Cridge. A brief discussion of methods of showing the percentage error. 800 w. Elec Engr, Lond—Dec. 7, 1906. No. 81007 A.

Standards.

Units and Standards. Editorial on the standardization of electrical units. 2200 w. Engng—Nov. 23, 1906. No. 80837 A.

Stray Currents.

The Measurement of the Density of Stray Currents in the Earth (Ueber die Messung der Dichtigkeit Vagabundierender Ströme im Erdreich). F. Haber and K. Liese. An illustrated account of extensive experiments at Karlsruhe, Germany, with plate electrodes covered with an electrolytic paste. Maps. Tables. 10000 w. Zeitschr f Elektrochem—Nov. 16, 1906. No. 81123 G.

MOTORS.

Direct Current.

The Design of Direct Current Motors. Charles H. Bedell. Discusses important points in the designs of motors for variable speed work. Ills. 2200 w. Sch of Mines Qr—Nov., 1906. No. 80855 D.

Induction Motors.

Some Practical Points on Polyphase Induction Motors. Fred P. De Wilde. Considers the rotating field, stator windings, test for field symmetry, drying out a water soaked motor, methods of speed control, etc. 1500 w. Power—Dec., 1906. No. 81001 C.

The Single-Phase Induction Motor. Alfred Still. Explains the action of the induction motor without reference to the idea of a resultant revolving magnetic field. 4000 w. Elec Wld—Dec. 8, 1906. Serial. 1st part. No. 80907.

Single Phase.

The Siemens-Schuckert Single-Phase Series Motor. Extracts from a recent paper by Dr. Rudolf Richter describing certain improvements in the design and construction of these motors. 2500 w. Elec Rev, Lond—Dec. 14, 1906. No. 81241 A.

Siemens-Schuckert Alternating-Current Series Motors. Rudolf Richter. Slightly abbreviated translation from the *Elektrotechnische Zeit.* Deals with the means employed by this company to improve the characteristics that are inferior to the continuous-current-motor. 3300 w. Elect'n, Lond—Nov. 23, 1906. Serial. 1st part. No. 80831 A.

TRANSMISSION.

Direct Current.

Direct-Current High-Voltage Transmission from Moutiers to Lyons, France (Gleichstrom - Hochspannungs - Kraftübertragung Moutiers-Lyon). Illustrated description of system and apparatus. Voltage is 57,000; distance, 110 miles. Also, table showing all D. C. transmissions on Thury system. 2000 w. Elektrotech Zeitschr—Nov. 22, 1906. No. 81158 B.

European Practice.

Present Status of European Practice in Transmission Line Work. Notes on the latest practice in Switzerland and Italy, with map of the Milan district. Also editorial. 3000 w. Elec Wld—Dec. 22, 1906. No. 81217.

Recent Practice.

Recent Practice in Electrical Transmission of Power. W. B. Esson. Discusses the economy of raising the pressure, and the pressures permissible, the design of insulators, switches, etc. Ills. 4000 w. Engr, Lond—Dec. 14, 1906. No. 81252 A.

MISCELLANY.

Canadian Westinghouse.

New Works of the Canadian Westinghouse-Co. at Hamilton, Ont. Description of a new plant intended for the manufacture of electrical products. Ills. 3500 w. Eng Rec—Dec. 15, 1906. No. 80995.

INDUSTRIAL ECONOMY

Accounting.

Smelter Administration. Herbert Haas. Describes a systematic method of keeping accounts at metallurgical works. 3300 w. Eng & Min Jour—Dec. 22, 1906. No. 81213.

Australia.

Industry and Politics of Western Australia. Ralph Stokes. Discusses the mining industry and the miner, and conditions affecting this industry. Ills. 2300 w. Min Wld—Dec. 8, 1906. No. 80898.

Betterment.

Betterment Work on the Santa Fé. A Complete account of this work, the results and methods used, and the effect on workmen, officials and owners. Ills. 17000 w. Am Engr & R R Jour—Dec., 1906. No. 80932 C.

Shop Betterment Work on the Santa Fé. Charles H. Fry. An explanation of the system of betterment work inaugurated to harmonize the relations between employer and employees, to increase the efficiency, etc. 8000 w. R R Gaz—Nov. 30, 1906. Serial. 1st part. No. 80766.

Electrical Industry.

The Electrical Industry at Home and

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Abroad. Dr. C. V. Drysdale. Address to the Students' Sec. of the Inst. of Elec. Engrs. Discusses the causes of the unsatisfactory state of affairs in England, and the progress in other countries. 7000 w. Elec Engr, Lond—Nov. 30, 1906. No. 80913 A.

Engineer's Role.

The Economic and Social Position of the Engineer (Le Rôle Economique et Social de l'Ingenieur). Prof. Maurice Bellom. Abstract of an inaugural lecture at the Ecole Nationale Superieure des Mines, of France. 8000 w. Génie Civil—Nov. 17 and 24, 1906. No. 81133 each D.

Foundry Costs.

A System for Obtaining Foundry Costs. C. J. Redding. A detailed description with facsimiles of all the forms necessary to put it into effect. The author points out especially the great commercial risk of rough "estimates" and incomplete knowledge of real costs. 4000 w. Engineering Magazine—Jan., 1907. No. 81192 B.

Inventions.

The Commercial Management of Inventions at Home and Abroad (Die Verwertung Technischer Neurerungen im In- und Auslande). Hermann Scherbak. An address before the Austrian Section of the Ver. Deutscher Ing., on inventions, the securing of patents and their selling, licensing, etc. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 17, 1906. No. 81143 D.

Labor.

Capital and Labor. John B. Kreischer. Address before the Stevens Engng. Soc. Considers the present conditions in the United States. 3500 w. Stevens Ind—Oct., 1906. No. 81092 D.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. The first of a series analyzing the common causes of "leaks," loss, and failure, and pointing out the plain, practical methods for bringing any manufacturing business up to its maximum possible productiveness and profit. 4500 w. Engineering Magazine—Jan., 1907. No. 81199 B.

Profit Sharing.

Sharing Profits of a Great Corporation. Remarks on the success of the Perkins plan of employee stockholders. 1200 w. Ir Trd Rev—Dec. 20, 1906. No. 81068.

Railroads.

The Relationshop of the Railroads to the People. Samuel Spencer. From an address delivered before the Alabama Agricultural Assn., Oct. 25, 1906. 3000 w. R R Gaz—Dec. 7, 1906. No. 80874.

Some of the Relations of Railway Transportation in the United States to Mining and Metallurgy. James Douglas. An interesting study of the effect of transportation on these industries; the effect of fuel and its value, and related problems of importance. 8500 w. Sch of Mines Qr—Nov., 1906. No. 80854 D.

MARINE AND NAVAL ENGINEERING

Araguaya.

The Royal Mail Steamer Araguaya. Illustrated description. 1000 w. Engr, Lond—Dec. 21, 1906. No. 81346 A.

Battleships.

U. S. S. Minnesota. R. T. Hall. Illustration, description and report of official trial. 10000 w. Jour Am Soc of Nav Engrs—Nov., 1906. No. 81281 H.

U. S. Battleship Nebraska. Arthur Crenshaw. Illustrations, description, and report of trials. 5000 w. Jour Am Soc of Nav Engrs—Nov., 1906. No. 81278 H.

The New Battleships of the French Navy (Les Nouveaux Cuirassés de la Marine Française). L. Piaud. Illustrated description of the "Patrie" and her class, with record of trials. 1 plate. 3000 w. Génie Civil—Dec. 1, 1906. No. 81134 D.

Boilers.

Some Practical Notes on the Care and Preservation of the Marine Type of Babcock & Wilcox Boilers. B. Heggenhaugen. Suggestions on getting a new boiler ready for steaming, getting up steam, firing, cleaning and inspection, feed water, etc. 8200 w. Jour Am Soc of Nav Engrs—Nov., 1906. No. 81282 H.

Channel Ferry.

The Proposed Channel Ferry Service. An account of a through rail connection proposed between England and France, with description of engineering features of interest. Ills. 2500 w. Engng—Dec. 7, 1906. No. 81026 A.

Coaling at Sea.

A New Sea Anchor for Coaling at Sea. Spencer Miller. An illustrated article reporting experiments and conclusions regarding sea anchors employed in marine cableways for coaling at sea. 1700 w. Ir Age—Nov. 29, 1906. No. 80765.

Cruiser.

U. S. S. Milwaukee. E. P. Jessop. Illustration, description and report of official trial. 2500 w. Jour Am Soc of Nav Engrs—Nov., 1906. No. 81280 H.

Drydocks.

Two Timber Drydocks and Their Pumping Plant. F. P. Palen and G. L. Smith. Illustrates and describes the two

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timber drydocks at Newport News, Va., and their pumping plant. 3000 w. Naut Gaz—Dec. 27, 1906. No. 81318.

Fireproof Ferry.

Construction of a Fireproof Ferry Steamer. William Gatewood. Read before the Soc. of Naval Archts. & Marine Engrs. An illustrated article giving particulars of an adaptation of fireproof construction in the building of the Jamestown, an excursion steamer for the Potomac river. Discussion. 7500 w. Marine Rev—Dec. 6, 1906. No. 80876.

Floating Dock.

The Naval Floating Dock—Its Advantages, Design and Construction. Discussion of the paper by Leonard M. Cox. 5000 w. Pro Am Soc of Civ Engrs—Dec., 1906. No. 81302 E.

Floating Fortress.

Steady-Floating Marine Structures. Illustrated description of the device invented by William Edward Murray which may modify the construction of breakwaters and other marine structures. Also editorial. 2500 w. Am Shipbldr—Dec. 8, 1906. No. 80906.

Gyroscope.

Experiments with the Marine Gyroscope (Versuche mit dem Schiffskreisel). O. Schlick. Description of experiments with a large gyroscope for diminishing the rolling of ships, made on board the "Seebär," a former torpedo boat, in the summer of 1906. Excellent results were obtained. Ill. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81149 D.

Life-Saving.

The Apparatus for the United States Life-Saving Service. Waldon Fawcett. Illustrates and describes devices found useful in this service. 1400 w. Sci Am—Dec. 29, 1906. No. 81294.

Model Basin.

The Uebigau Experiment Station (Die Versuchsanstalt "Uebigau"). Fr. Gebers. Illustrated description of large model basin and testing plant for ships' models, propellers, etc., near Dresden, Saxony. 3 plates. Serial. 2 parts. 4500 w. Schiffbau—Oct. 10 and 24, 1906. No. 81116 each D.

Motive Power.

The Motive Power of a 25¼-Knot Liner. An interesting illustration and explanation representing the horse-power necessary to drive the new Cunard liners. 1500 w. Sci Am—Dec. 15, 1906. No. 80974.

Olive Oil Lubricant.

How a Barrel of Olive Oil Saved the Staff of the Navy; An Incident in American Naval History. F. P. Albert. An interesting account relating to the professional work of Com. B. F. Isherwood, and, particularly, the story of the use of olive oil for lubricating journals of the "Wampanoag." 4500 w. Eng News—Dec. 27, 1906. No. 81286.

Paddle-Wheel.

Performance of the Paddle-Wheel Steamboat New York of the Hudson River Day Line. James E. Denton. Read before the Soc. of Nav. Archts. & Marine Engrs. A report of the results of speed and power trials. Ills. 800 w. Naut Gaz—Nov. 29, 1906. No. 80840.

Princess Ena.

The Channel Steamship Princess Ena. Illustrated description of the latest addition to the Channel fleet of the London & S.-W. Ry. 1200 w. Engr, Lond—Dec. 7, 1906. No. 81029 A.

Propellers.

New Aspects of the Design and Construction of Screw Propellers (Neuere Gesichtspunkte für die Konstruction und den Entwurf von Schiffschrauben). A. Ackenbach. Illustrated discussion of various new propellers. 1500 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81154 D.

A Comparison of Durand's and Curtis and Hewins' Propeller Experiments of 1905. Read before the Soc. of Nav. Archts. & Marine Engrs. Compares data given in papers by writers named. 600 w. Int Marine Engng—Jan., 1907. No. 81221 C.

Refrigeration.

See Mechanical Engineering, Heating and Cooling.

Research Boat.

The German Marine Research Boat "Planet." Herrmann Albrecht. Brief illustrated description of this vessel and some of the instruments and methods of work to be used, outlining the character of the researches to be made. 700 w. Sci Am—Dec. 22, 1906. No. 81084.

Steamboat.

The Western River Steamboat. A. H. Blaisdell. An illustrated article describing the construction of these boats, their propelling machinery and other equipment, their performance, etc. Gives tests made of some of these boats, and information of interest. 4500 w. Jour Assn of Engng Socs—Oct., 1906. No. 81067 C.

Submarines.

The Submarines and Submersibles of France. An account of various vessels constructed since 1885, with illustrations and information concerning them. 4000 w. Engr, Lond—Dec. 21, 1906. No. 81347 A.

Turbine Steamer.

Launch of the American Turbine Steamship Yale. An illustrated description of this vessel which is to ply on "the outside line" between New York and Boston, with an account of the launch. 2500 w. Naut Gaz—Dec. 6, 1906. No. 80889.

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MECHANICAL ENGINEERING

AUTOMOBILES.

Accelerometer.

The Lanchester Accelerometer. Illustrates and describes an instrument for the measurement of starting and brake efforts. 1500 w. Autocar—Dec. 8, 1906. No. 81018 A.

Armstrong-Whitworth.

The 28-36-H. P. Armstrong-Whitworth Car. Begins an illustrated detailed description of this new touring car. 5000 w. Auto Jour—Nov. 24, 1906. Serial. 1st part. No. 80810 A.

Autoloc.

The Autoloc, an Automatic and Instantaneous System of Clamping (L'Autoloc, Systéme de Blocage Automatique et Instantané). M. A. Morel. Illustrated description of clamp or clutch, having a cam held in place by balls connected with a spring, and mathematical discussion of its principle. 2000 w. Génie Civil—Dec. 8, 1906. No. 81139 D.

Dismountable Chassis.

The Lacain Dismountable Chassis for Automobiles (Chassis Démountable pour Automobiles, Systéme Lacain). Pierre Noël. Illustrated description of frame which can be taken apart between the front and rear wheels, to enable the same engine to be used with different bodies. 1500 w. Génie Civil—Dec. 1, 1906. No. 81136 D.

France.

Development of the French Automobile Industry. Remarks on the Paris Salon and the position of the French industry in the present article. 1500 w. Engr, Lond—Dec. 14, 1906. Serial. 1st part. No. 81254 A.

Frost.

Precautions Against Frost. E. W. Walford. Information in regard to precautionary measures and remedial measures in cases of damage to cars by frost. 1800 w. Autocar—Dec. 15, 1906. No. 81233 A.

Garages.

Up-to-Date Development of the Garage. Howard Greene. An illustrated article explaining the conveniences of the modern garage, and the devices used. 3000 w. Automobile—Dec. 20, 1906. No. 81099.

Gears.

The Johnston-Buddicom Change-Speed Gear. Illustrates and describes a device of the bevel differential or balance gear type, working in oil, in an oil-tight casing. 1200 w. Autocar—Dec. 8, 1906. No. 81019 A.

The Johnston-Buddicom Epicyclic Gear. Illustrates and describes a car on which this gear is installed, and also a pneumatic system by which either "speed" can be brought into play. 2200 w. Auto Tour—Dec. 15, 1906. No. 81230 A.

Marvel Runabout.

Another Detroiter: The Marvel Runabout. Illustrated description of a two-passenger vehicle, propelled by a four-cycle two-cylinder opposed motor. 1200 w. Automobile—Dec. 27, 1906. No. 81292.

Materials.

Materials Used in Motor-Car Construction. E. J. Bartlett. Considers the more important materials used for this class of work with the general reasons for their selection. 2500 w. Am Mach—Vol. 29. No. 52. No. 81268.

Mercedes.

The Austrian Mercedes Petrol-Electric Cars. An illustrated description of these vehicles with remarks on the system. 1200 w. Auto Jour—Dec. 8, 1906. No. 81016 A.

Olympia Exhibition.

The Olympia Motor-Car Exhibition. An account of this successful show, giving illustrated descriptions of some of the exhibits. 8500 w. Engng. Nov. 23, 1906. Serial. 1st part. No. 80836 A.

Motor Car Engineering. Illustrates and describes engineering details shown at the Olympia exhibition. 2500 w. Mech Engr—Dec. 1, 1906. Serial. 1st part. No. 80917 A.

Paris Salon.

Review of the Paris Motor Show. Illustrates and describes features of the exhibits. 5000 w. Autocar—Dec. 15, 1906. Serial. 1st part. No. 81234 A.

Pneumatic Hub.

A New Design Pneumatic Hub. Brief illustrated description of the invention of G. W. Bell, using compressed air as a buffer. 800 w. Automobile—Dec. 13, 1906. No. 80965.

Producer Gas.

Producer Gas as a Fuel Substitute. Information concerning a gas-producer small enough to make the entire plant suitable for installation on an ordinary car. Ills. 1200 w. Automobile—Dec. 27, 1906. No. 81291.

Race Course.

Brooklands Motor Race Course. Plan and description of this English race course, nearing completion, with abstract of the more important regulations. Ills. 2500 w. Auto Jour—Dec. 22, 1906. No. 81329 A.

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Rims.

Detachable Rims. Brief illustrated descriptions of several designs. 1400 w. Auto Jour—Dec. 1, 1906. No. 80904 A.

Rolls-Royce.

The 6-Cylinder 40-45-H. P. Rolls-Royce Cars. Illustrated article describing particulars of this new British car. 1500 w. Auto Jour—Dec. 8, 1906. No. 81017 A.

Starter.

An Automatic Carbonic Acid Gas Starter for Automobile Motors. Illustrated description of the new apparatus known as the Cinogene, a device for starting the motor of an automobile without having to turn the starting crank. 800 w. Sci Am Sup—Dec. 8, 1906. No. 80881.

Steam Vehicles.

Five-Ton Steam Wagon. Illustrated detailed description of a vehicle built in Liverpool. The leading characteristics are two engines driving rear wheels through Renold chains, and a fan-cooled condenser and spring hubs. 2300 w. Engng—Dec. 14, 1906. No. 81248 A.

Steam as a Motive Power for Public Service Vehicles. Thomas Clarkson. Presents the advantages of steam for public service work, and gives an illustrated detailed description of an automatic steam generator and its operation when applied to omnibuses. 6500 w. Inst of Mech Engrs—Nov. 16, 1906. No. 80838 N.

Storage Batteries.

The Proper Size and Voltage of Storage Battery Cells for Electric Automobiles. Frank B. Rae. A discussion of points affecting the selection of the size of a vehicle battery. 1700 w. Elec Wld—Dec. 15, 1906. No. 81054.

Wheels.

Wire and Wood Wheels. John V. Pugh. Considers the relative merits of wire and wood wheels, their durability, etc. Ills. 2400 w. Autocar—Dec. 22, 1906. Serial. 1st part. No. 81328 A.

COMBUSTION MOTORS.

Gas Engines.

Gas-Engine Types. Jonas F. King. Gives considerations regarding the various systems, based on the findings of a commission of engineers appointed to examine carefully the whole subject of gas engines. 2000 w. Power—Dec., 1906. No. 81000 C.

Gas Engine Testing.

Rules for the Testing of Gas Engines and Gas Producers (Regeln für Leistungsversuche an Gasmaschinen und Gaserzeugern). Regulations proposed by the Society of German Engineers, Society of German Engine Builders and Society of Large Gas Engine Manufacturers, in 1906. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 24, 1906. No. 81148 D.

Gasolene Engines.

A Comparison of Four-Cycle Gasolene Engines as Used in Automobile Service. E. J. Bartlett. Considers types of engines used, showing graphically the arrangement of the reciprocating and revolving parts and the relative steadiness of the power developed by each type. Ills. 2800 w. Am Mach—Vol. 29. No. 52. No. 81267.

Horse Power.

Some Notes on the H. P. of Petrol Motors. Prof. J. Blacklock Henderson. Deals with scientific principles underlying the calculation of the power. 2000 w. Autocar—Dec. 15, 1906. No. 81232 A.

Ignition.

Ignition. R. H. Coombs. The first of a series of articles dealing with the average troubles, and their cause, in modern ignition outfits. 2000 w. Rudder—Dec., 1906. Serial. 1st part. No. 80878 C.

Indicator.

A New French Optical High-Speed Gas-Engine Indicator. Brief illustrated description of an interesting indicator for extremely high speeds. 500 w. Am Mach—Vol. 29. No. 48. No. 80761.

Inflammable Gases.

The Testing of Inflammable Gases. C. E. Sargent. Illustrates and describes apparatus designed and used by the writer in making efficiency tests of gas engines and in determining the solid matter, moisture, and calorific value of gases. 2000 w. Pro Am Soc of Mech Engrs—Dec., 1906. No. 81064.

Lubrication.

Lubrication Systems for Gas Engines. Herbert L. Towle. An illustrated discussion of methods of feeding the oil and a description of lubricators for automobiles and power boats. 5000 w. Rudder—Dec., 1906. No. 80877 C.

The Lubrication of Petrol Engines. J. Veitch Wilson. Refers to an article by H. O. Duncan, explaining points with which the writer fails to agree, and stating his views in regard to lubricants. 3000 w. Autocar—Dec. 8 and 15, 1906. Serial. 2 parts. No. 81231 each A.

Marine Engines.

Explosive-Mixture Motors. A. B. Willits. Remarks on the possibility of applying explosive mixture motors to seagoing craft, and some of the objectionable features of steam installations that would disappear. Illustrates and describes present motor designs, and discusses the fuel question. Ills. 7800 w. Jour Am Soc of Nav Engrs—Nov., 1906. No. 81279 H.

Pistons.

Pistons for Internal Combustion Engines. H. S. Brown. Discusses the conditions to be considered in designing such pistons, their lubrication, and re-

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lated matters. Ills. 1800 w. Ir Age—Dec. 27, 1906. No. 81260.

Spark Coils.

The Care and Use of Spark Coils. E. Q. Williams. Brief suggestions for avoiding troubles with spark coils. The necessity of keeping everything clean and dry. 800 w. Sci Am—Dec. 8, 1906. No. 80880.

Turbines.

Gas Turbines. Frank Foster. Discusses some of the problems that must be solved before a reliable internal-combustion turbine can be made. Ills. 3000 w. Mech Engr—Dec. 8, 1906. Serial. 1st part. No. 81021 A.

HEATING AND COOLING.

Assembly Rooms.

The Warming and Ventilation of Churches, Halls and Theatres. Charles L. Hubbard. Brief discussion of successful methods. 2500 w. Eng Rec—Dec. 29, 1906. No. 81308.

Chart.

Graphical Calculation of Feed-Water Heaters. N. A. Carle. Gives a chart plotted from straight-line formula, and one from Poole's logarithmic formula with examples of their application. 1500 w. Power—Dec., 1906. No. 80999 C.

Detached Building.

Heating and Ventilating Plant of a Detached College Building. R. E. Chandler. Illustrates and describes the plant installed at the Oklahoma Agricultural and Mechanical College, at Stillwater, Okla. 600 w. Heat & Vent Mag—Dec., 1906. No. 81097.

Engineering Building.

Heating and Ventilation of the Engineering Building at the University of Pennsylvania. Illustrates and describes the system of heating by direct radiation, with mechanical ventilation systems for the more important rooms. 2700 w. Eng Rec—Dec. 8, 1906. No. 80910.

Exhaust Steam.

Features of Exhaust Steam Heating. Charles L. Hubbard. Considers some of the advantages and objections relating to the use of exhaust steam, with suggestions. 1500 w. Heat & Vent Mag—Dec., 1906. No. 81098.

Greenhouse.

Greenhouse and Conservatory Heating. A. S. Atkinson. Considers a hot-water plant, properly installed and equipped, to serve the purpose better than any other system, and discusses some of the essentials. 2000 w. Sci Am Sup—Dec. 15, 1906. No. 80980.

Johnson.

Johnson System of Temperature Regulation. Illustrates and describes the construction, principle of operation and application of thermostat to direct and indirect systems of heating. 2200 w. Engr, U S A—Dec. 1, 1906. No. 80800 C.

N. Y. Subway.

Experimental Cooling System in the New York Subway. Outlines the work that has been done for ventilating and cooling the subway air in warm weather, giving an illustrated description of the experimental plant installed at the Brooklyn Bridge Station. 1600 w. Elec Ry Rev—Dec., 1906. No. 81046.

Refrigeration.

Cold Storage on Board Ship. Sydney F. Walker. Discusses causes of failure, and points of importance in the case of a ship refrigerating system. 4500 w. Int Marine Engng—Jan., 1906. Serial. 1st part. No. 81220 C.

Brine Circulation vs. Direct Expansion. Oswald Gueth. Presents the comparative advantages and disadvantages of brine and direct expansion systems of utilizing the cooling effect of an expanding gas. 3000 w. Engr, U S A—Dec. 1, 1906. No. 80799 C.

Description of a Cold Storage Plant Utilizing Exhaust Steam. Henry Torrance, Jr. Read before the Am. Soc. of Refrig. Engrs. An illustrated article showing what can be done in cold storage warehouses, with the absorption system of mechanical refrigeration, using exhaust steam from the auxiliary machinery. 800 w. Eng Rec—Dec. 29, 1906. No. 81309.

HYDRAULICS.

Diagram.

A New Diagram for Hydraulic Calculations. Frank Foster. Gives a diagram applicable whether or not there are losses due to skin friction or eddies. 800 w. Mech Engr—Dec. 1, 1906. No. 80916 A.

Fire Protection.

Automatic Sprinkler System for Fire Protection. Describes the equipment of works of the Ohio Brass Co., at Mansfield, Ohio. 1600 w. Met Work—Dec. 29, 1906. No. 81290.

Pumping.

Pumping Without an Air Chamber. George A. Stacy. An account of such working, showing that an air chamber is of value even when not necessary to the action of the pump. Discussion. 2200 w. Jour N Eng W-Wks Assn—Dec., 1906. No. 81094 F.

Tidal Power.

The Use of Tidal Power for Compressing Air at Rockland, Me. William O. Webber. Brief account of this scheme, which is an unproved Frizell method for compressing air by tidal power. 600 w. Eng News—Dec. 6 1906. No. 80844.

Turbines.

The Design of the Wheels and Buckets of Turbines and Centrifugal Pumps (Die Bestimmung der Kranzprofile und der

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Schaufelformen für Turbinen und Kreiselpumpen). Prof. F. Prasil. Mathematical discussion of turbine design. Diagrams. Serial. 1st part. 1500 w. Schweiz Bauzeitung—Dec. 8, 1906. No. 81105 B.

MACHINE WORKS AND FOUNDRIES.

Boiler Works.

The West Point Boiler Works. Illustrated detailed description of these Pittsburg shops and their equipment. 2200 w. Boiler Maker—Dec., 1906. No. 80813.

Card Index.

A Method of Indexing and Numbering Tools. Linwood A. Murray. An account of a card system used by the writer which gave satisfaction. 1500 w. Am Mach—Vol. 29. No. 51. No. 81073.

Castings.

Accuracy and Economy in Castings. Walter J. May. Discusses methods of reducing the waste and total works charges to as low a point as possible. 1000 w. Prac Engr—Dec. 7, 1906. No. 81020 A.

A New Process for Avoiding the Formation of Flaws in Heavy Steel Castings. Dr. Alfred Gradenwitz. Illustrated description of a process recently developed in Germany for use in connection with castings up to 60 tons weight. 1000 w. Prac Engr—Nov. 23, 1906. No. 80823 A.

The use of Chills in Making Aluminum Castings. Amos Brown. An illustrated explanation of the use of chills on heavy portions of aluminum castings instead of risers. 1000 w. Brass Wld—Dec., 1906. No. 81270.

Chains.

The Manufacture of a Detachable Sprocket Chain. Illustrates and describes some of the machines and methods employed. 2200 w. Am Mach—Vol. 29. No. 52. No. 81266.

Cincinnati Co.

New Shops of the Cincinnati Machine Tool Company. Brief description, with illustrations, of a shop of modern construction. 700 w. Am Mach—Vol. 29. No. 48. No. 80760.

Collinwood.

A Few Specialties of the Collinwood Shops. Illustrates and describes special tools used in these shops of the L. S. & M. S. Ry. to reduce cost and increase the output. 2000 w. Ry Mas Mech—Dec., 1906. No. 80952.

Core Boxes.

Multiple Core Boxes. H. N. Tuttle. Discusses some ways of making boxes when it is customary to taper both prints. 1500 w. Foundry—Dec., 1906. No. 80942.

Costs.

Machine Shop Costs. William Cunningham. Brief description of methods followed by the Westinghouse Electric and Manufacturing Company, with general remarks and discussion. 5000 w. Pro Engrs' Soc of W Penn—Dec., 1906. No. 81060 D.

Cutting Metals.

On the Art of Cutting Metals. Fred W. Taylor. Presidential address. Gives information of great value gathered during years of investigation for the improvement of shop practice, and forming a review of developments in the art of cutting metals. Many plates. 17000 w. Pro Am Soc of Mech Engrs—Dec. 4, 1906. Vol. 28. No. 3. No. 80848 N.

Dies.

Sub-Press Work at the Sloan & Chace Shops. An illustrated description of small sub-press dies built at this shop in Newark, N. J. 4000 w. Mach, N Y—Dec., 1906. No. 80782 C.

Drawing Room.

Drawing-Office Practice of the General Electric Company. John W. Upp. Information regarding the sizes, titles, indexing and conventions used. Ills. 2000 w. Am Mach—Vol. 29. No. 51. No. 81072.

Quick Drafting. Charles Prescott Fuller. Recommends the universal use of the full size scale for part size drawings. 1800 w. Am Mach—Vol. 29. No. 51. No. 81076.

Drill.

A Radial Driller. Illustrated description of a new design, one object of which is to provide a ready means of changing from cone-driven to geared speed-box drive. 500 w. Am Mach—Vol. 29. No. 50. No. 80957.

Foundry Costs.

The Reduction of Foundry Costs. H. Cole Estep. Discusses in detail the problem of cost production. 2800 w. Foundry—Dec., 1906. No. 80939.

Gear Cutting.

Gear-Cutting Machines. Illustrated description of specific tools, with discussion of methods employed to produce accurate spur teeth. 17500 w. Engr, Lond—Nov. 23, 1906. No. 80839 A.

Gear Cutting Machines. Illustrates and describes machines used for cutting of very high ratio spiral or helical gears, which require great accuracy. 700 w. Engr, Lond—Dec. 7, 1906. No. 81033 A.

The Chamban Bevel-Gear-Cutting Machine (Machine a Tailler les Engrenages Coniques de MM. Chamban et Cie. à Lyon). G. Eude. Illustrated description. 2000 w. Rev de Mécanique—Nov. 30, 1906. No. 81129 E + F.

Heating Furnaces.

Heating Furnaces for Shipbuilding (Wärmöfen in Schiffbaubetrieben). Hr. Gille. Illustrated description of coal, gas

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and other kinds of furnaces for heating metal parts used in shipbuilding. Serial. 1st part. 1800 w. Schiffbau—Nov. 28, 1906. No. 81119 D.

Keys.

Solid Keys. J. J. Siebert. Describes the working of keys of the worms, gears, worm-wheels, etc., of sights for naval guns. Ills. 600 w. Am Mach—Vol. 29. No. 51. No. 81075.

Marion Steam Shovel.

Plant of the Marion Steam Shovel Co. An illustrated description of the plant and of methods of manufacturing excavating machinery. 3500 w. Ir Trd Rev—Dec. 6, 1906. No. 80864.

Molding.

Loam Molding. E. L. Rhead. The present article considers the kinds of loam, and the materials and appliances required. 4000 w. Mech Engr—Dec. 22, 1906. Serial. 1st part. No. 81332 A.

Molding Machines.

The Loose Pattern and the Machine-Mounted Pattern. G. Buchanan. An illustrated account of a great saving in time, labor and cost by the use of a molding machine. 1200 w. Am Mach Vol. 29. No. 49. No. 80842.

A new Line of Molding Machine Practice. Illustrates and describes some of the latest developments in French machines. The process of Ph. Bonvillain. 5600 w. Foundry—Dec., 1906. No. 80938.

The Bonvillain Molding Machine. Illustrates and describes some of the latest developments in French molding machines. 4800 w. Ir Trd Rev—Nov. 29, 1906. No. 80752.

The Rathbone Multiple Molding Machine. Illustrated description of this method of multiple molding, reporting good results and economy. 2000 w. Met Work—Dec. 29, 1906. No. 81289.

Patterns.

A Bevel Gear Pattern. H. J. McCaslin. Illustrates and describes the laying out gear, obtaining the profile of tooth ends, laying out the jig block, sanding the teeth, and making the body of patterns. 2300 w. Foundry—Dec., 1906. No. 80941.

The Making of a Crooked Elbow. Jabez Nall. Illustrated description of method used. 1500 w. Foundry—Dec., 1906. No. 80943.

Pneumatic Hammers.

Electrically-Operated Pneumatic Hammers. Frank C. Perkins. Illustrates and describes such hammers, giving samples made in England, Germany, and the United States. 700 w. Sci Am Sup—Dec. 15, 1906. No. 80977.

Power Consumption.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines-Outils). C. Codron. A continuation of the author's well-known experiments, as described in the *Bulletin Société d'Encouragement.* The present article treats of reaming. Ill. Serial. 1st part. 2500 w. Rev de Mécanique—Nov. 30, 1906. No. 81128 E + F.

Punch.

Automatic Punching Machine for Plates (Selbsttätige Lochmaschine für Bleche). Tjard Schwarz. Illustrated description of machine for punching rivet holes in plates for shipbuilding, etc. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 17, 1906. No. 81142 D.

Rolls.

Paper Mill Rolls. A query and answer in regard to making brass shells for paper mill rolls. 1800 w. Foundry—Dec., 1906. No. 80940.

Round Bars.

A New Method of Rolling Round Bars. Illustrated description of the Tafel round-bar mill and its operation, giving some of the results obtained. 1400 w. Ir Age—Dec. 20, 1906. No. 81071.

Soldering.

Some Cautions to Be Observed in Soldering. Arthur B. Weeks. Gives examples of troubles caused by too generous use of acid for soldering on electrical machinery. 700 w. Elec Ry Rev—Dec., 1906. No. 81047.

Spacing Table.

The Spacing Table in Steel Fabricating Plants. George P. Thomas. Gives a comparison of cost of punching holes by various methods, and gives an illustrated description of a spacing table, explaining its advantages. 2300 w. Ir Trd Rev—Dec. 6, 1906. No. 80866.

Springs.

A Review of Formulas for Helical Springs. O. A. Thelin. Gives a new solution of certain problems. 500 w. Am Mach—Vol. 29. No. 52. No. 81269.

Precision Dynamometer Springs. A. H. Emery, Jr. Illustrates and describes methods of doing a remarkable piece of work. 2400 w. Am Mach—Vol. 29. No. 48. No. 80763.

Taps.

Tapper Taps. Erik Oberg. Describes the tapper tap and its use, its design and making. 1100 w. Mach, N Y—Dec., 1906. No. 80784 C.

"Tiffany Green."

"Tiffany-Green" and Its Method of Production. G. Erlenmeyer. Describes the method of obtaining this rich finish for castings. Ills. 1500 w. Brass Wld—Dec., 1906. No. 81271.

Trimmer.

The Fox Universal Trimmer. Illustrated description of an improved wood trimmer. 1000 w. Ir Age—Nov. 29, 1906. No. 80764.

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MATERIALS OF CONSTRUCTION.

Bolts.

Flange Bolts. John D. Adams. Explains the writer's method of determining the number and size of bolts necessary to hold down a pillar crane. 1500 w. Mach, N Y—Dec., 1906. No. 80781 C.

Brittleness.

The Influence of Temperature an the Brittleness of Metals (Sur l'Influence de la Température sur la Fragilité des Métaux. G. Charpy. Drop tests on five bars of steel of various makes and with various alloys. Curves and tables. 1800 w. Mem Soc Ing Civ de France—Oct., 1906. No. 81124 G.

Cast Iron.

The Influence of Carbon on Cast Iron. Abstract of a report of research work by W. H. Hatfield, on "The Influence of the Condition of the Several Varieties of Carbon Upon the Strength of Cast Iron, as Cast and Heat Treated." 2500 w. Ir Age—Dec. 27, 1906. No. 81259.

Flat Plates.

The Resistance of the Flat Walls of Steam Boilers and Other Steam Holders Zur Widerstandsfähigkeit Ebener Wandungen von Dampfkesseln und Dampfgefässen). C. Bach. Theoretical discussion of the strength of flat plates of various shapes. Ill. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81150 D.

Lubricants.

The Purification of Lubricating Oil. James L. Grant. Illustrates various types of oil filters describing their working and showing the true economy of using good oil and filtering to purify and use again. 1500 w. Elec Wld—Dec. 1, 1906. Serial. 1st part. No. 80808.

Rails.

Steel Rails. Robert Job. Considers the effect of structure, heat treatment, the influence of the type of section, overloading, etc. Ills. General discussion. 9200 w. Pro NY RR Club—Nov. 16, 1906. No. 80937.

Tubes.

Resistance of Tubes to Collapse. Albert P. Carman and Maurice L. Carr. Describes a series of experiments made on the resistance of metal tubes of boiler-tube size and less, when subjected to external hydraulic pressure. 2500 w. Am Mach—Vol. 29. No. 50. No. 80956.

Wheels.

Cast-Iron Wheels and Their Chemical Composition. James Andrews. Discusses the effect of the pouring temperature, and of the composition on the quality of the wheels. 4300 w. St Ry Jour—Dec. 8, 1906. No. 80901.

MEASUREMENT.

Calorimeter.

The Wallace Alcohol Calorimeter. Diagram and description of the instrument devised by Prof. Wallace for the testing of coal. Alcohol is used as the heat-measuring liquid. 1700 w. Engr, Lond—Dec. 21, 1906. No. 81344 A.

Metric System.

Our Present Weights and Measures and the Metric System. Discussions of Henry R. Towne's paper on this subject, contributed by members. 11500 w. Pro Am Soc of Mech Engrs—Dec., 1906. No. 81065 C.

Some Objections to the Compulsory Introduction of the Metric System. C. M. Watson. Discusses the arguments usually presented in favor of this system, and gives reasons against its compulsory introduction. Also general discussion. 12600 w. Jour Soc of Arts—Dec. 7, 1906. No. 81014 A.

Slide Rule.

A Cost-Estimating Slide Rule. W. L. Miggett. Describes a multiple slide rule and explains its use, giving examples of its application. 2500 w. Am Mach—Vol. 29. No. 51. No. 81074.

Springs.

The Strength of Coil Springs. H. E. Wimperis. An endeavor to determine the fundamental conditions and more important formulæ which govern the design of coiled springs. 2800 w. Engr, Lond—Nov. 30, 1906. No. 80927 A.

Steel Strains.

A Study of the Molecular Changes of a Steel Rod under Tensile Stress (Studie über die Molekularen Veränderungen eines durch Zug Beanspruchten Stahlstabes). Capt. Max Kralupper. Determination of the elastic limit magnetically, and other experimental and theoretical studies. Diagrams. Serial. 1st part. 1600 w. Oest Zeitschr f Berg u Hüttenwesen—Dec. 1, 1906. No. 81115 D.

POWER AND TRANSMISSION.

Autoloc.

See Mechanical Engineering, Automobiles.

Ball Bearings.

The Mechanical Design of Ball Bearings and Roller Bearings. W. S. Rogers. A critical survey of the fallacies of inventors and designers, illustrating the points of error and pointing out the sound principles of construction and the free state of the art for new manufacturing enterprise. 2500 w. Engineering Magazine—Jan., 1907. No. 81191 B.

Bearings.

The Design of Bearings. Forrest E. Cardullo. Discusses the friction of journals, and results obtained from the machines for testing bearings, in the present article. 2200 w. Mach, N Y—Dec., 1906. Serial. 1st part. No. 80780 C.

Centrifugal Compressor.

Turbo-Compressor, on the Rateau and

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Armengaud System (Turbo-Compresseur. Systeme Rateau et Armengaud). Alfred Barbezat. Illustrated description of steam-turbine driven centrifugal air compressor, for supplying air to a gasoline turbine, built at Brown, Boveri & Co.'s works. Diagrams. 2000 w. Schweiz Bauzeitung—Nov. 17, 1906. No. 81103 B.

Rateau's Turbo-Compressor. Illustrated description of this device, invented by Auguste Rateau, explaining the arrangement and its advantages. 1100 w. Mech Engr—Nov. 24, 1906. No. 80825 A.

Compressed Air.

Greater Economy Needed in the Production of Compressed Air. Considers the saving in power possible by cooling during compression, clearance in compressor cylinders, and factors affecting compressor capacities. 2200 w. Sci Am Sup—Dec. 22, 1906. No. 81090.

Elevators.

The Hydraulic Elevator. William Baxter, Jr. Discusses the fundamental principles of different types. 3000 w. Power—Dec., 1906. No. 81002 C.

Gas Power.

Gas as a Source of Power. Willard L. Case, in *Jour. of Soc. of Chem. Ind.* Gives facts from authoritative sources concerning the generation of producer, Mond, and blast-furnace gases. 3500 w. Sci Am Sup—Dec. 15, 1906. Serial. 1st part. No. 80981.

Gas Power Plants (Ueber Kraftgasanlagen). R. Schöttler. Illustrated discussion of gas power in general, producers, blast-furnace gas and gas engines. Serial. 2 parts. 5500 w. Elektrotech Zeitschr—Nov. 29 and Dec. 6, 1906. No. 81159 each B.

100-Brake-Horse-Power "Ruston" Suction Gas Producer and Engine. Illustrates and describes this plant, built in England. 800 w. Engng—Dec. 21, 1906. No. 81343 A.

Suction Gas Engines and Gas Plants. Hugh Campbell. Deals with their modern aspect and the condition of both as they exist today. 8000 w. Plates. Trans Inst of Engrs & Shipbldrs in Scotland—Nov. 20, 1906. No. 81298 N.

The Trials of Suction Gas Plants at Derby, 1906. Gives tables and results of the trials of suction-gas producers held by the Royal Agricultural Society. 6000 w. Engr, Lond—Dec. 14, 1906. Serial. 1st part. No. 81255 A.

The Munzel Gas Engine and Producer. Illustrated description of this engine and suction gas producer. 1500 w. Ir Age—Dec. 20, 1906. No. 81070.

The Operation of Lean-Gas Producers (Representation du Fonctionnement des Gazogènes à Gaz Pauvres). H. Sire de Vilar. Mathematical and graphical discussion; with examination of results of several different experimenters. 1 plate. 3500 w. Mem Soc Ing Civ de France—Oct., 1906. No. 81126 G.

Characteristics of Some Power Gases and Their Treatment. L. L. Brewer. Considers the impurities, methods of cleaning the gas, etc. 4000 w. Power—Dec., 1906. No. 81004 C.

Gears.

Complete Graphical Solution of Spiral Gears. E. H. Fish. Gives an explanation of graphical methods for solving all problems without mathematics. 1700 w. Am Mach—Vol. 29. No. 48. No. 80762.

Governors.

Care of Air Governors. H. Schlegel. Gives a diagram showing the connections of the Christensen air governor, and explains its automatic operating features. 1000 w. St Ry Jour—Dec. 29, 1906. No. 81320.

Office Buildings.

Power and Heat for Office Buildings. Charles L. Hubbard. Notes prepared for the use of architects, aiming to assist them in determining approximately the space to be reserved for the power and heating plant. 5000 w. Eng Rec—Dec. 1, 1906. No. 80821.

Power Plant.

The Planning and Construction of the Power Plant. A. E. Dixon. An illustrated review of the leading types of main and auxiliary machinery, with the advantages and disadvantages peculiar to each. 3500 w. Engineering Magazine—Jan., 1907. No. 81194 B.

Pulleys.

Single Pulley Drives. William F. Groene. Presents the advantages possessed by the single pulley drive, and also the disadvantages, and discusses the requirements of the ideal drive, and compares the merits of proposed designs. 1700 w. Mach, N Y—Dec., 1906. No. 80783 C.

Travellers.

The Erection of an Over-head Traveller. E. G. Fiegehen. Describes the usual course of erection for a 10-ton hand-power traveller for a span of 40 feet. Ills. 3000 w. Prac Engr—Dec. 14, 1906. No. 81235 A.

Unloader.

The Clark Freight Unloader. Illustrated description of a portable freight-unloading machine and its operation. 1200 w. Ir Age—Dec. 27, 1906. No. 81258.

Variable Speed.

The Newman Variable Speed Gear. Emile Guarini. Illustrates and describes a new gear brought out in England, intended for application to motor cars, machine tools, textile machinery, electric motors, etc. From a shaft driven at a constant speed a complete range of speeds can be obtained. 1000 w. Sci Am Sup—Dec. 8, 1906. No. 80882.

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Workshop Power.

The Choice of Motive Power for the Workshop. R. E. Mathot. A careful, impartial illustrated study of various types of steam, gas, and oil engines for comparatively small plants under a wide range of conditions. Concrete examples are freely used by way of illustration. 3500 w. Engineering Magazine—Jan., 1907. No. 81198 B.

STEAM ENGINEERING.

Boilers.

Boiler Mountings for a Scotch Boiler. J. Q. Walton. Discusses good and bad arrangements, the location of valves, etc. 3000 w. Boiler Maker—Dec., 1906. No. 80814.

Boilers for Colliery Purposes. F. C. Swallow. Abstract of a paper read before the S. Staffordshire and Warwickshire Inst. of Min. Engrs. considering the type of boilers best suited for colliery purposes. 2500 w. Col Guard—Dec. 14, 1906. No. 81244 A.

See also Marine Engineering.

CO_2 Recorder.

The "Ados" Automatic CO_2 Recorder for Boiler Furnaces. Illustrates and describes a new type of recorder, designed in England, which is based upon the fact that a solution of caustic potash absorbs CO_2. 2000 w. Sci Am Sup—Dec. 22, 1906. No. 81091.

Modernizing a Manufacturing Concern. Describes the writer's experience with the installation of superheaters, and with an automatic CO_2 recorder. 1500 w. Prac Engr—Dec. 21, 1906. No. 81330 A.

Condensers.

Condensers for Steam Engines and Turbines. Frank Foster. Abstract of a paper read before the Owens College Engng. Soc., Oct., 1905. Discusses the best vacuum for turbines and reciprocating engines, cost of condensing plant, and the power required by the auxiliaries. 3500 w. Power—Dec., 1906. No. 81005 C.

Eolipile.

An Historical Account of the Eolipile; an Ancient Steam Generator. S. J. Berard. Reviews some early uses of the expansive force of steam, illustrating and describing the eolipiles, and explaining the applications made of the device. 2000 w. Yale Sci M—Dec., 1906. No. 81056 C.

Explosion.

The Cradley Heath Boiler Explosion. A report of the investigation of the fatal boiler explosion on July 4, 1906, giving illustrations showing the effect. 10000 w. Engng—Dec. 14, 1906. No. 81251 A.

Feed Water.

Boiler Feeding. R. T. Strohm. Considers the methods of introducing feed water into steam boilers and their merits. 2000 w. Elec Wld—Dec. 1, 1906. No. 80809.

Hoisting Engines.

Test of a Modern Winding Engine. David A. Bremner. An analysis of tests carried out on a compound non-condensing winding engine at the Sherwood Colliery. Ills. 2500 w. Engr, Lond—Dec. 14, 1906. No. 81253 A.

Induced Draught.

Practical Notes on the Application of Fans for Induced Draught and Other Purposes. W. H. Casmey. Presents the importance of air-moving machines and the economies to be effected by their use. 3000 w. Elec Engr, Lond—Nov. 10, 1906. No. 80912 A.

Injectors.

Injectors (Injektoren). Ph. Michel. Discussion of the theory of the injector, and description of experiments. Ill. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81151 D.

Leakage.

Direct-Leakage of Steam Through Slide Valves. J. V. Stanford. Gives results of some experiments made to determine some facts in connection with leakage of slide valves. 1500 w. Jour Fr Inst—Dec., 1906. No. 80945 D.

Lubrication.

Methods of Internal Lubrication. Robert R. Keith. Illustrates and briefly describes various types of lubricators. 1300 w. Engr, U S A—Dec. 15, 1906. No. 81050 C.

Piping.

High Pressure Steam Piping in Marine Work (Hochdruckdampfrohrleitungen im Schiffsbetriebe). Hr. Uthemann. Discussion of materials, joints, flanges, etc., with illustrations. 2400 w. Zeitschr d Ver Deutscher Ing—Nov. 24, 1906. No. 81145 D.

Piston Wear.

Cylinder and Piston Wear in Large Horizontal Engines. L. H. Edwards. A plea for a change in piston design. Ills. 900 w. Power—Dec., 1906. No. 81003 C.

Rolling Mill Engines.

Heavy Corliss Engines. Illustrated description of heavy engines especially constructed for rolling-mill service. 1200 w. Engr, U S A—Dec. 1, 1906. No. 80798 C.

Steam.

The Influence of Steam Consumption on the Quality of Steam Generated in a Boiler. G. W. Burley. Reports the results of trials made to determine the quality of the steam generated under different conditions of load and steam consumption. 700 w. Elec Engr, Lond—Dec. 14, 1906. No. 81240 A.

Steam Flow.

The Dynamics of the Flow of Steam in Reciprocating Engines (Zur Dynamik der Dampfströmung in der Kolbendampfmaschine). W. Schüle. A compre-

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hensive mathematical discussion. Diagrams. Serial. 3 parts. 10000 w. Zeitschr d Ver Deutscher Ing—Nov. 24, Dec. 1 and 8, 1906. No. 81146 each D.

Superheating.

The Superheating of Steam and its Distribution by Balanced Valves (La Surchauffe de la Vapeur et sa Distribution par Soupapes Equilibrées). L. Piaud. Illustrated description of apparatus for both stationary and locomotive work. Serial. 2 parts. 4500 w. Génie Civil—Dec. 8 and 15, 1906. No. 81138 each D.

Traps.

Steam Traps. W. H. Wakeman. Illustrates and describes appliances worthy of adoption wherever steam is used for heating or drying purposes, or for long pipe lines. 5700 w. Sci Am Sup—Dec. 8, 1906. No. 80883.

Turbines.

Actual Turbine Results—Report of the Condition of Turbines after a Year of Use—Steam and Coal Consumption in Actual Service. A report submitted by B. S. Josselyn on the condition and performance of the turbines at the Gould St. power station in Baltimore. Ills. 1500 . Power—Dec., 1906. No. 80998 C.

Operating Experience with Four-Stage Curtis Turbines. Abstract of a paper by C. E. Stanton, read before the Iowa Elec. Assn., giving experience at Dubuque, Iowa. 2200 w. Eng Rec—Dec. 29, 1906. No. 81310.

The Development and Present Status of the Steam Turbine in Land and Marine Work. Discussion of paper by E. M. Speckman. 5000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Oct. 23, 1906. No. 81297 N.

The Parsons Steam Turbine. John D. Bailie. Discusses modern turbines, showing the maintenance of high vacua is quite practicable at moderate working costs, and considers the subject of the steam turbine taking the exhaust steam of the reciprocating engine and economically converting it into power, and other subjects of interest. Ills. 3500 w. Ir & Coal Trds Rev—Dec. 7, 1906. Serial. 1st part. No. 81036 A.

Turbo-Compressor.

See Mechanical Engineering, Power and Transmission.

Water Purification.

Some Experiences in Softening Water. W. C. M'Cracken. Gives details of a trial of the process and modifications adopted at the Ohio State University. 2500 w. Engr, U S A—Dec. 15, 1906. No. 81051 C.

The Mechanical Clarification and Filtration in Water Purifiers (Die Mechanische Klärung und Filterung in Wasserreinigern). Walter Rottmann. Illustrated description of various kinds of water purifying apparatus. 2000 w. Zeitschr d Ver Deutscher Ing—Dec. 1, 1906. No. 81152 D.

The Paterson Oil Eliminator and Water-Softener. Illustrates and describes this apparatus for effecting the complete extraction of oil from feed-water by chemical means, as well as softening the make-up water when necessary. 2200 w. Engng—Dec. 21, 1906. No. 81342 A.

MISCELLANY.

Aeronautics.

Aerial Locomotion. A brief review of the work of past experimenters and the present work in this field. 3500 w. Engng—Dec. 14, 1906. No. 81247 A.

Dirigible Airships. Count von Zeppelin. Discusses the design and propulsion of airships. 4000 w. Sci Am Sup—Dec. 22, 1906. No. 81088.

Experiences in Balloons. Dr. Julian P. Thomas. An illustrated report of the personal experiences of the writer who makes many ascensions from New York. 2500 w. World's Work—Dec., 1906. No. 80849 C.

Recent Airship and Aeroplane Experiments in Europe. Illustrates and describes recent craft and gives reports of flights attempted and attained. 3300 w. Sci Am—Dec. 22, 1906. No. 81086.

The Conquest of the Air. Bernard Meiklejohn. A review of what has been accomplished with balloons, dirigible airships, aeroplanes and the helicoptere. Ills. 5700 w. World's Work—Dec., 1906. No. 80850 C.

The Second Annual Exhibition of the Aero Club of America. Brief illustrated descriptions of some of the interesting exhibits. 2300 w. Sci Am—Dec. 15, 1906. No. 80975.

Genesis of the First Successful Aeroplane. Editorial on the work of the Wright brothers of Dayton, Ohio. 1200 w. Sci Am—Dec. 15, 1906. No. 80972.

Art Smith.

An Art Smith and His Work. Principally an account of the work of Louis Van Boeckel, at Lier, near Antwerp. Ills. 1800 w. Am Mach—Vol. 29. No. 49. No. 80841.

Blowpipe Welding.

Welding by Means of the Oxy-Acetylene Flame (Ueber das Schweissen mit der Sauerstoff-Azetylenflamme). Dr. L. Michaelis. Discussion of oxygen-acetylene blowpipe welding, and comparison with oxy-hydrogen welding, based on an address of M. Edouard Fouché, with illustrations. Serial. 2 parts. 3000 w. Schiffbau—Nov. 28, Dec. 12, 1906. No. 81118 each D.

Energetics.

Reflections on Energetics (Réflexions

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sur l'Energétique). V. Dwelshauvers-Dery. A theoretical discussion of energy in general and a comparison between gravitation energy and heat energy. 8000 w. Rev de Mécanique—Nov. 30, 1906. No. 81127 E + F.

Mechanical Equivalent.

Methods for Determining the Equivalence Between Heat and Work (Ueber die Methoden zur Bestimmung der Aequivalenz von Wärme und Arbeit). Theodor Gross. History of methods, the principles on which they rest and the conclusions to be drawn therefrom. Serial. 1st part. 2000 w. Elektrochem Zeitschr—Dec., 1906. No. 81121 G.

Paper Making.

Paper Making by Electric Power. Illustrated description of a remodeled plant at Hartford City, Ind., equipped with a Diesel oil engine driving direct —an alternating-current generator. 2200 w. Engr, U S A—Dec. 1, 1906. No. 80797 C.

Reichenberg Exposition.

The German-Bohemian Exposition at Reichenberg in 1906 (Die Deutschböhmische Ausstellung in Reichenberg 1906). Prof. Theobald Demuth. Illustrated description of transmission machinery, gearing, machine tools and other exhibits. Serial. 1st part. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 17, 1906. No. 81141 D.

Telescope.

Equatorial Twin Telescope at the Radcliffe Observatory, Oxford. An illustrated account of this instrument and the tower and dome containing it. 4000 w. Engng—Dec. 21, 1906. No. 81340 A.

Thermit.

The Welding of Large Pieces, Especially in the Repairing of Ships, by Means of Thermit (Grosse Schweissungen Mittels Erwärmungsmasse Marke "Thermit," besonders bei Reparaturen im Schiffbau). Illustrated description of welding of broken stern posts, rudder frames, etc., by the aluminothermic process. Serial. 2 parts. 3500 w. Schiffbau—Oct. 10 and 24, 1906. No. 81117 each D.

Wire Manufacture.

The Drawing of Copper Wire (Das Ziehen von Kupferdraht). Wilhelm Küppers. Well illustrated description of machinery and processes at various German works for the manufacture of wire and cables, chiefly for electrical purposes. Serial. 2 parts. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 24 and Dec. 15, 1906. No. 81144 each D.

MINING AND METALLURGY

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Classification.

The Classification of Coals. S. W. Parr. Read before the Am. Chem. Soc. Considers the factors of composition which should be taken into account to obtain a practical and scientific classification. 2500 w. Mines & Min—Dec., 1906. No. 80758 C.

Coal-Cutting Machinery.

Experience with Coal-Cutting Machinery in the Dortmund District (Neuere Erfahrungen mit Maschineller Schrämarbeit in den Dortmunder Bergrevieren). E Reinke. Descriptions of mining machines and operations. Ill. 4500 w. Glückauf—Oct. 20, 1906. No. 81106 D.

Coke Ovens.

Flued Coke Oven Doors. Brief illustrated description of doors designed by T. Beach, which have given success in coking the coal completely right up to the oven door. 500 w. Col Guard—Nov. 23, 1906. No. 80834 A.

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The Greaves Coal Face Conveyor. Illustrated description of the features of interest in this conveyor of the scraper type. 1100 w. Col Guard—Dec. 7, 1906. No. 81006 A.

Deposition.

The Maximum Deposition of Coal in the Appalachian Coal Field. George Hall Ashley. The first of a series of three papers dealing with the time interval involved in the laying down of the coal of the Carboniferous. 1700 w. Ec Geol—Sept., 1906. Serial. 1st part. No. 80860 D.

Dust Danger.

The Dust Danger. W. H. Pickering. Read before the Inst. of Min. Engrs. Considers briefly the sources of coal dust, its danger, methods of remedying, and the difficulties. 1500 w. Min Rept—Dec. 6, 1906. No. 80895.

Electrical Equipment.

Electrical Equipment of the United States Coal and Coke Co. in the Pocahontas Coal Field. George R. Wood. Illustrates and describes the modern methods of mining and handling coal by means of electrical power, in this West Virginia coal field. 4000 w. Mines & Min—Dec., 1906. No. 80754 C.

Illinois.

A Modern Coal Mine. M. F. Peltier. Illustrated description of the equipment and methods of the Illinois Midland Co., at a plant near Springfield. 2200 w. Eng & Min Jour—Dec. 29, 1906. No. 81315.

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Production.

The World's Coal Production and Consumption. Statement from the last report issued by the British Board of Trade. 2500 w. Col Guard—Nov. 30, 1906. No. 80923 A.

Tipple.

A Modern Coal Tipple. Freeman R. Willson. Elevation and description of a tipple at the new Boissevain mine of the Pocahontas Colliery Co. 800 w. Eng & Min Jour—Dec. 1, 1906. No. 80796.

West Virginia.

Coal Mining at Holden, W. Va. R. H. Lyman. An illustrated article describing the location, development and operation. 1400 w. Eng & Min Jour—Dec. 15, 1906. Serial. 1st part. No. 80989.

Coal Mining in the Fairmont Field, West Virginia. F. W. Parsons. Brief history of this coalfield, with description of the mining methods, which represent the most modern American practice. Map. 1700 w. Eng & Min Jour—Dec. 1, 1906. Serial. 1st part. No. 80795.

COPPER.

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The Greenwater Copper District, California. William C. Ralston. An illustrated outline of present conditions at the mines of this district. 1300 w. Eng & Min Jour—Dec. 15, 1906. No. 80984.

Colorado.

Copper in Colorado. Gives production statistics, and information relating to the distribution, occurrence, and character of the ores. 1500 w. Min Rept—Dec. 20, 1906. No. 81223.

Concentrating.

The Wall Concentrating Mill. Claude T. Rice. Illustrated description of works at Bingham, Utah, and the devices for dressing copper ore which are inventions of Col. E. A. Wall. 2000 w. Eng & Min Jour—Dec. 1, 1906. No. 80793.

Japan.

Sumitomo Bessi; the Great Copper Mine of Japan. O. G. Bennett, Jr. An illustrated review of a large mining and smelting plant established and operated on strictly modern lines but altogether by Japanese initiative and engineering skill. 3500 w. Engineering Magazine—Jan., 1907. No. 81197 B.

Lake Superior.

Geology of Keweenaw Point. Alfred C. Lane. Illustrates and describes the geology of these copper-bearing rocks in the Lake Superior basin. 3800 w. Mines & Min—Dec., 1906. No. 80756 C.

The Copper Range Consolidated Properties. Arthur L. Carnahan. Reviews the past, and discusses the present and future of these mines, which in 1905 contributed over a quarter of the whole production in the United States. 2500 w. Min Wld—Dec. 1, 1906. Serial. 1st part. No. 80776.

Nevada.

Methods of Mining at Ely, Nevada. C. Everard Arnold. An account of methods adopted for the profitable working of low-grade copper ore. Ills. 1100 w. Min & Sci Pr—Nov. 24, 1906. No. 80801.

Schuyler Mine.

History of the Schuyler Mine. J. H. Granbery. An illustrated account of the first copper mine operated in the United States, located in Bergen County, N. J. 2800 w. Eng & Min Jour—Dec. 15, 1906. No. 80988.

Smelting.

The Kiddie Hot-Blast System for Copper-Smelting Furnaces. E. Jocobs. Describes this new system, and discusses its cost, economy, etc. Ills. 2500 w. B C Min Rec—Oct., 1906. No. 80811 B.

The Wallaroo Smelting Works. Discussion of paper by T. C. Cloud on these copper smelting works of South Australia. 6500. Inst of Min & Met—Bul No. 27. Dec. 13, 1906. No. 81265 N.

Spain.

The Esperanza Mine, Spain. Edward Walker. Map, plans, and account of a new copper-mining enterprise in the Huelva district. 1500 w. Eng & Min Jour—Dec. 22, 1906. No. 81214.

Virginia.

The Virgilina Copper Belt. Edward K. Judd. An illustrated account of this district, lying half in Virginia, and half in North Carolina, stating its advantages and neglected opportunities. 2000 w. Eng & Min Jour—Dec. 1, 1906. No. 80792.

Wire Manufacture.

See Mechanical Engineering, Miscellany.

GOLD AND SILVER.

Assaying.

Assay of Bullion Containing Selenium. J. E. Clennell. Notes on methods adopted in sampling and assaying bullion at the Redjang Lebong mine, Sumatra. 3000 w. Eng & Min Jour—Dec. 8, 1906. No. 80884.

Some Notes on Assaying. Charles H. Fulton. Notes having some novel features, prepared for use at the South Dakota School of Mines. 1200 w. Min Wld—Dec. 22, 1906. Serial. 1st part. No. 81227.

The Assay of Gold Bars as Conducted in the Author's Assay Office. Arthur C. Claudet. Describes the method in detail. 2200 w. Inst of Min & Met—Bul No. 27. Dec. 13, 1906. No. 81263 N.

British Columbia.

Reconnaissance Around the Nickel Plate Mine, B. C. Horace F. Evans. A study of this region, its geology, deposits

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of auriferous and copper ores, and their workings. 2500 w. Min Wld—Dec. 1, 1906. No. 80778.

California.

The Old Way and the New. Frank Drake. Brief account of the early operations and present methods of mining for the purpose of comparison. 1400 w. Min & Sci Pr—Dec. 8, 1906. No. 80961.

Clean-Up.

Cyanide Works' Clean-Up Practice. Jas E. Thomas. Gives suggestions of what is required in the design of cyanide plants, as regards the clean-up floors. 1700 w. Jour Chem Met & Min Soc of S Africa—Oct., 1906. No. 81015 E.

Cobalt.

Cobalt-Mines. W. J. Blair. Reviews the history of this silver district, where arsenic, cobalt, nickel, bismuth, copper, iron, lead, zinc and gold are also found. 1500 w. Can Min Rev—Dec., 1906. No. 81069 B.

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The Later History of Guanajuato. T. A. Rickard. An illustrated account of recent enterprises of importance. 3000 w. Min & Sci Pr—Dec. 22, 1906. No. 81287.

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Hydraulic Mining in Colorado. W. E. Thorne. Gives some of the actual costs in this class of mining in Colorado, as conducted at a high altitude and during short seasons of from four to five months. Ills. 1200 w. Min & Sci Pr—Dec. 8, 1906. No. 80959.

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Mining Economics.

West Australian Gold Mining Costs. A valuable paper dealing with method of accounting for a group of mines. 2000 w. Min & Sci Pr—Dec. 8, 1906. No. 80958.

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The Seven-Mile (Nanango) Goldfield. Lionel C. Ball. History and description of this field, with special reference to the occurrence of true ruby. Map. 3500 w. Queens Gov Min Jour—Oct. 15, 1906 No. 80921 B.

Rand.

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Reduction.

A Method of Determining Hydrogen Peroxide and Ferrous Salts and Other Reducing Agents. W. E. Mathewson and J. W. Calvin. Reports tests made, giving results obtained with ferrous ammonium sulphate and sodium nitrate. 1000 w. Min Rept—Dec. 13, 1906. No. 81040.

Silver-Zinc.

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Methods of Slimes Treatment. C. Everard Arnold. Describes the method of slime treatment employed by the North Star Mines Co., of Grass Valley, Cal. 900 w. Aust Min Stand—Oct. 17, 1906. No. 80803 B.

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Silver-Lead Smelting on the West Coast of Tasmania. T. Kapp. Explains methods of treating economically the refractory ores of very low grade, containing zinc. 2500 w. Min Jour—Dec. 22, 1906. No. 81339 A.

Stamp Mill.

The Palmer Mountain Mill. Illustrated description of a new electrically operated stamp mill in the state of Washington. 1400 w. Eng & Min Jour—Dec. 8, 1906. No. 80888.

Temiskaming.

A Microscopic Examination of the Cobalt Nickel Arsenides and Silver Deposits of Temiskaming. W. Campbell and C. W. Knight. Gives the results of the application of microscopic methods of examination to the cobalt-nickel silver veins of Temiskaming. Ills. 2500 w. Ec Geol—Sept., 1906. No. 80858 D.

IRON AND STEEL.

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Mining Methods at the Larger Minette Iron Mines of the Diedenhofen District in Alsace-Lorraine (Die Abbauverfahren auf den Grösseren Minettegruben des Bergreviers Diedenhofen in Elsass-Lothringen). Dr. Ahlburg. Illustrated description of underground work. 5000 w. Glückauf—Nov. 24, 1906. No. 81110 D.

Blast Furnaces.

Notes on Blast Furnace Practice. H. Pilkington. Abstract of an address before the British Found. Assn. Brief account of the development of the blast furnace, and methods of handling materials, with a suggestion for an ideal foundry plant having blast-furnaces, making pig iron, and producing gas to supply all the power required. Ills. 2000 w. Ir & Coal Trds Rev—Dec. 7, 1906. No. 81037 A.

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Blowholes and Pipes in Steel (Blasen und Lunker in Flusseisen und Flussstahl). Wilhelm Kusel. Illustrated discussion of these defects in steel ingots and blocks, and methods for preventing them. Serial. 2 parts. 5000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 17 and 24, 1906. No. 81113 each D.

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The Colorado Fuel and Iron Company. Lawrence Lewis. An illustrated article giving the history of the development of this company, which is the largest industrial corporation west of Chicago. Map. 2300 w. Eng & Min Jour—Dec. 29, 1906. No. 81313.

Electro-Metallurgy.

See Electrical Engineering, Electro-Chemistry.

Hardening.

Mistakes in Hardening Processes and Their Causes (Härtefehler und Ihre Ursache). J. H. Heckel. Address at the Vienna Exhibition of the Hardening and Tempering Industry, giving a general account of the heat treatment of steel. 4000 w. Oest Zeitschr f Berg u Hüttenwesen—Oct. 20 and 27, 1906. No. 81111 each D.

Hardening and Annealing by Electricity. Illustrated description of an electrically heated furnace for hardening steel, intended to replace gas and coke fires, or the lead and salt baths. 900 w. Elec Rev, Lond—Nov. 23, 1906. No. 80828 A.

India.

The Manufacture of Iron and Steel in India. Facts and figures taken from the comprehensive report of C. M. Weld and Mr. Perrin, favorable to the industry. Discusses the site selected, its resources, the type of plant, and probable cost of manufacture. 4000 w. Ir & Coal Trds Rev—Dec. 7, 1906. No. 81035 A.

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Underground Mining on the Mesabi Iron Range. Rush T. Sill. Brief description of the method of mining. 1100 w. Min Wld—Dec. 1, 1906. No. 80779.

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The Problem of Mining Sandy Ore at Coleraine. An illustrated account of two mining towns being built by the Steel Corporation, the unusual conditions, methods of washing the ore, etc. 3000 w. Ir Trd Rev—Dec. 6, 1906. No. 80865.

MINING.

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An Appliance for Automatically Stopping and Restarting Mine Wagons. W. Galloway. Illustrated description of an appliance for arresting the motion of a full or empty wagon without shock, holding it as long as necessary, and pushing it forward with any desired velocity. 1500 w. Min Jour—Dec. 22, 1906. No. 81338 A.

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Development in the Explosives Art in the United States During the Last Five Years. Charles E. Munroe. A review of changes in the explosive business and details of methods in use. 2500 w. Sci Am Sup—Dec. 29, 1906. No. 81296.

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Assistant Inspectorship of Mines. Gives papers set to candidates at a recent examination in England. 1800 w. Col Guard—Nov. 30, 1906. No. 80924 A.

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The Development of the Metal Mining Industry of the Western States. Waldemar Lindgren. A summary of recent mining history, the methods, conditions, recent improvements, and progress. 3000 w. Min & Sci Pr—Dec. 1, 1906. No. 80863.

Ore Deposits.

Relation of Eruptive Rocks to Ore Deposits. Etienne A. Ritter. Considers primary segregation due to igneous activity. 1000 w. Ores & Met—Dec. 15, 1906. No. 81039.

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Solutions.

On a New Method for the Preparation of Standard Solutions. S. F. Acree and R. F. Brunel, in *Am. Chem. Jour.* Describes the sodium bicarbonate method for estimating the strength of acid solutions, giving examples showing its accuracy and convenience. 2000 w. Min Rept—Dec. 20, 1906. No. 81224.

Sulphides.

A Process for Oxidizing Metallic Sulphides in Ores. N. Lebedeff and B. Pomeranzoff. Describes a process of preparing ores containing sulphides for final treatment by wet and dry means, so that the metal may be extracted. 700 w. Eng & Min Jour—Dec. 8, 1906. No. 80885.

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Development and Transportation Tunnel Enterprises in the Argentine District, Colorado. Brief accounts of the more important of the tunnel enterprises of this district, and of the development and equipment of properties. 3000 w. Min Rept—Dec. 6, 1906. No. 80896.

Water Race.

The Water Race for the Chuquitambo Gold Mines, Peru. G. F. Heath. Describes the construction of this water race, giving a statement of the conditions, the cost, and related matters of interest. 2500 w. Inst of Min & Met—Bul No. 27—Dec. 13, 1906. No. 81264 N.

MISCELLANY.

Altai.

Mining and Metallurgy in the Altai Region, Siberia (Berg-Hütten-und Salinenwesen im Altai). F. Thiess. Map and statistical account of mineral products, including gold, silver, copper, coal and salt, of the Altai Mountain region, in southern Siberia. 1000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 17, 1906. No. 81114 D.

Antimony.

The Antimony Industry. F. T. Havard. Discusses the value and uses of antimony, the methods of smelting etc. 2500 w. Eng & Min Jour—Dec. 1, 1906. No. 80794.

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Australia.

Geology and Geological Survey of Western Austrialia. Ralph Stokes. Outlines the work of the geological survey. 2500 w. Min Wld—Dec. 22, 1906. No. 81226.

Heat Treatment.

The Heat Treatment of Metallurgical Products (Traitement Thermique des Produits Métallurgiques). Léon Guillet. Account of experiments with various metals and alloys, and discussion of results. Diagram and tables. 1 plate of micrographs. 10000 w. Mem Soc Ing Civ de France—Oct., 1906. No. 81125 G.

Law.

Do the Geological Relations of Ore Deposits Justify the Retention of the Law of the Apex, Letters from Courtenay DeKalb, and William F. Robertson, discussing this law. 3300 w. Ec Geol—Sept., 1906. No. 80861 D.

The Right to Minerals on Railroad Lands. Courtenay DeKalb. Brief discussion of the agitation in Nevada to secure legislation permitting the valid location of mining claims on railroad grant lands. 1000 w. Min & Sci Pr—Dec. 22, 1906. No. 81288.

Lead.

Lead Mining in British Columbia. A review of the progress made since payment of the bounty on lead was commenced. 2500 w. B C Min Rec—Oct., 1906. No. 80812 B.

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The Mines of Planchas de Plata. F. J. H. Merrill. Describes the interesting geology of this mining district of Sonora, the character of the ore bodies, and treatment of the ore. Map. 1200 w. Eng & Min Jour—Dec. 15, 1906. No. 80986.

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The Microscopic Examination of Opaque Minerals. William Campbell. Describes the method employed for preparing the specimens, illustrating the microscopes and accessories. 4500 w. Ec Geol—Sept., 1906. No. 80857 D.

New Zealand.

The Salient Features of the Economic Geology of New Zealand. James Mackintosh Bell. Describes the chief physiographic features, and the distribution of coal, petroleum, iron ore, copper, gold, platinum, tin, and other minerals. 4400 w. Ec Geol—Sept., 1906. No. 80856 D.

Oil Deodororizing.

New Methods of Deodorizing Petroleum, Shale Oil and Tar Oil (Nouvelles Méthodes de Déodorisation des Pétroles des Huiles de Schistes et des Huiles de Goudron). Joseph Girard. Discussion of the chemical composition of oils, and description of indirect and direct methods of deodorization. Serial. 1st part. 3000 w. Génie Civil—Dec. 15, 1906. No. 81140 D.

Plating.

Gold Plating Steel Belt-Buckles. Describes a method of obtaining good work which is also economical. 800 w. Brass Wld—Dec., 1906. No. 81273.

The Care of Nickel Solutions. Points of importance to success in nickel plating are discussed. 1200 w. Brass Wld—Dec., 1906. No. 81274.

Platinum.

Methods of Extraction of Platinum in Russia and the United States. Describes the various methods used for the mining and recovery of platinum. 2000 w. Min Rept—Nov. 29, 1906. No. 80786.

Salt Mining.

The Artificial Lixiviation of Rock Salt (Die Künstliche Verlaugung dès Haselgebirges). C. Schraml. An illustrated description of a rock-salt mining process, in which the material is mixed with water, which dissolves the salt, and is conducted through pipes to a collecting chamber. Serial. 2 parts. 5000 w. Oest Zeitschr f Berg u Hüttenwesen—Oct. 27, and Nov. 3, 1906. No. 81112 each D.

Slags.

Tests of Titaniferous Slags. Charles N. Cox, Jr., and Loring C. Lennox. A study of results of quite an extensive series of tests on the feasibility and fluidity of actual slag mixtures containing varying per cents of titanic acid. 4000 w. Elec-Chem & Met Ind—Dec., 1906. No. 81055 C.

Talc.

The Talc Industry of the United States. Joseph Hyde Pratt. Describes the late deposits of various localities, and gives the principal uses made of the product. 1500 w. Min Wld—Dec. 29, 1906. No. 81326.

Tin.

The Annan River Tinfield. Walter E. Cameron. An illustrated description of the general features, geology, deposits, and mining. 4200 w. Queens Gov Min Jour—Oct. 15, 1906. Serial. 1st part. No. 80920 B.

Tin in Northern Territory. Information from the report of the Government Geologist, concerning these tinfields of Australia. 2800 w. Aust Min Stand—Oct. 17, 1906. No. 80802 B.

Wisconsin.

Wisconsin Zinc and Lead Deposits. Albert A. Hoskin. States the writer's hypothesis for explaining these deposits, discussing its special features. 3500 w. Min Rept—Nov. 29, 1906. No. 80785.

Zinc and Lead Deposits in the Wisconsin Field. Albert A. Hoskin. Considers these deposits and their origin, the relation between surface and underground ranges, and facts supporting the

We supply copies of these articles. See page 838.

hypothesis of deposition from above. 3000 w. Min Rept—Dec. 6, 1906. Serial. 1st part. No. 80892.

Zinc.

The Gravimetric Estimation of Zinc. Charles E. Reuger. Describes in detail the phosphate method which is highly accurate. 1500 w. Min Wld—Dec. 29, 1906. No. 81325.

Zinc Dross.

Zinc Dross and Its Refining. Describes the character of this material and the method of reclaiming the zinc. Ills. 1000 w. Brass Wld—Dec., 1906. No. 81272.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

What Can Be Done to Reduce the Number of Railway Accidents? Editorial discussion with opinions from other sources. 4000 w. Eng News—Dec. 6, 1906. No. 80847.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Large Pumps and 100-Car Train. Discusses the advisability of adopting larger air-pumps for long trains, showing that a larger pump than the 9½-in. is required for modern service. 1500 w. Ry & Loc Engng—Dec., 1906. No. 80872 C.

Bearings.

Axle Bearings for Heavy Tonnage Wagons; Indian Railways. H. Kelway Bamber. Considers difficulties due to increased loads, and the remedies. Discusses the kind of bearings necessary and the lubrication. 1100 w. Engng—Dec. 14, 1906. No. 81245 A.

Brakes.

Practical Views on Brake Rigging. Franklin M. Nicholl. Discusses the most common forms of brake rigging as applied to double-truck equipments. 1200 w. St Ry Jour—Dec. 8, 1906. No. 80903.

New Westinghouse Quick-Acting Brake. Illustrates and describes the improved triple valve and its action, reporting tests. 2200 w. Engng—Dec. 7, 1906. No. 81027 A.

Buffer Displacement.

Experiments on the Relative Displacement of the Buffers of Neighboring Cars (Expériences Faites en 1897 à la Cie. Paris-Lyons-Méditerranée sur le Déplacement Transversal Relatif des Tampons Voisins de Deux Véhicules Consécutifs d'un Train). MM. Chabal and Beau. Illustrated account of experiments with trains on curves and on tangents, on the Paris-Lyons-Mediterranean Ry. Diagrams. 3500 w. Rev Gén des Chemins de Fer—Dec., 1906. No. 81130 G.

Car Lighting.

Acetylene Car Lighting on the Great Northern. Illustrated description of the individual gas generator for each car, and its application. 1000 w. Ry Age—Nov. 30, 1906. No. 80789.

Electric Locomotive.

Tests of the Ward-Leonard-Oerlikon Electric Locomotive. Reports the results of recent tests of this electric locomotive. Diagrams. 1200 w. St Ry Jour—Dec. 8, 1906. No. 80900.

Electrification.

Report of the Commission on the Electrification of the Swiss Railways (Mitteilungen der Schweizerischen Studien-Kommission für Elektrischen Bahnbetrieb). Prof. W. Wyssling. An elaborate study of the power required. Tables. Serial. 2 parts. 5000 w. Schweiz Bauzeitung—Oct. 20, & 27. 1906. No. 81100 each B.

The Electrification of the Simplon Tunnel. An interesting illustrated account of this work, the conditions and difficulties. 4000 w. Engng—Nov. 23, 1906. No. 80835 A.

Progress in Electrification of the Rochester Division, Erie R. R. Describes this installation, now approaching completion. 1200 w. Ry & Engng Rev—Dec. 8, 1906. No. 80887.

Steam Locomotive and Electric Operation for Trunk-Line Traffic—A Comparison of Costs and Earnings. F. J. Sprague's discussion of the paper on this subject by Joseph Mayer. 4500 w. Pro Am Soc of Civ Engrs—Dec., 1906. No. 81300 E.

Locomotives.

Balanced Compound for the N. P. Illustrated detailed description of a 4-6-2 passenger engine of the Pacific type built with four-cylinders in the form of a balanced compound. 1000 w. Ry & Loc Engng—Dec., 1906. No. 80870 C.

Baldwin Balanced Compound. Illustrated description of a four-cylinder balanced compound of the 2-6-2 type for fast freight service. 600 w. Ry & Loc Engng—Dec., 1906. No. 80873 C.

Compound Locomotive for the Kansei Railway, Japan. Illustration, with description of engines recently built in America for this railway of Japan. 700 w. RR Gaz—Dec. 21, 1906. No. 81210.

British-Built Locomotives for Service Abroad. Charles S. Lake. An illustrated review of types recently shipped. 1200 w. Mech Engr—Dec. 22, 1906. No. 81331 A.

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Continental Locomotives at the Milan Exhibition. Illustrates and describes interesting types shown. 4000 w. Engr, Lond—Dec. 7, 1906. No. 81031 A.

Four-Cylinder Balanced Compound Locomotive with Inclined High Pressure Cylinders. Illustrations and details of these powerful locomotives for the A., T., & S. F. Ry. 500 w. Am Engr & RR Jour—Dec., 1906. No. 80933 C.

Four-Cylinder Compound Express Locomotive for the Danish State Railways. Drawings and description of engines for working the heaviest passenger train service on the main lines of Denmark. 1700 w. RR Gaz—Dec. 14, 1906. No. 80967.

Four-Cylinder Compound Locomotive; Austrian State Railways. Dimensions and illustrated description. 800 w. Engng—Dec. 14, 1906. No. 81249 A.

Four-Cylinder Compound Locomotives with Lentz Valves. Plate and description of an engine built for the Prussian State Railways, and exhibited at Milan. 1000 w. Engng—Nov. 30, 1906. No. 80926 A.

Four-Cylinder 2-10-0 Type Locomotive, Austrian State Railways. Charles S. Lake. Illustrated description of a specially designed locomotive for piloting the heaviest train over the Arlberg division of the State Railways. 600 w. Mech Engr—Nov. 24, 1906. No. 80824 A.

New Locomotives for National Rys. of Mexico. Illustrates and describes five Pacific type locomotives recently completed for these lines. There are three different classes, which are compared. 2000 w. Ry & Engng Rev—Dec. 29, 1906. No. 81349.

Prairie Type Compound Engines at Milan Exhibition. Illustrates and describes a locomotive for the Austrian State Railways. 900 w. Engr, Lond—Nov. 30, 1906. No. 80928 A.

Six-Coupled Tank Locomotive, with Lentz Reversing Gear. Illustrated description of an interesting small engine exhibited at Milan. 500 w. Engng—Dec. 21, 1906. No. 81341 A.

Six-Wheels Coupled Locomotives for Pessenger and Goods Service on the Caledonian Railway. Charles S. Lake. Illustrates three new classes of these locomotives recently introduced, with their leading dimensions. 800 w. Mech Engr—Dec. 1, 1906. No. 80919 A.

Some Interesting Types in Development of Four-Cylinder Compound Locomotives. Illustrated descriptions of recent designs, including a Cole compound, Vauclain balanced compound, and Mallet articulated compound. 2200 w. Ry Mas Mech—Dec., 1906. No. 80963.

Tank Locomotive for the Kiushiu Railway of Japan. Illustrated description of engines built in America for this Japanese railway. 300 w. Ry Age—Dec. 7, 1906. No. 80899.

The Stephensons and the Development of the Locomotive. H. J. Thorkelson. Reviews the early history of the use of steam for propulsion, and especially the important work done by the Stephensons. Ills. 7500 w. Wis Engr—Dec., 1906. No. 81276 D.

Locomotive Service.

High Steam Pressures in Locomotive Service. W. F. M. Goss. A statement of methods of research to determine the value of high steam pressures in locomotive service, discussing the results. General discussion. 15400 w. Pro W Ry Club—Nov. 20, 1906. No. 81058 C.

Management.

The Motive Power Officer of a Great Railway. G. M. Basford. Address before the Mech. Engng. Sec. of Purdue Univ. Presents some of the mechanical problems at present before these officers, and the talents needed to cope with this important work. 4000 w. Sci Am Sup—Dec. 29, 1906. No. 81295.

Motor-Cars.

Recent Steam Rail Motor-Cars. Charles S. Lake. Illustrates and describes types in which the engine is a separate unit instead of being carried on the same framing as the car body. 1000 w. Mech Engr—Dec. 8, 1906. No. 81022 A.

The Kobusch-Wagenhals Steam Motor Coach. Illustrated description of a recently completed coach built by the St. Louis Car Company. 4500 w. Sci Am Sup—Dec. 22, 1906. No. 81087.

Steel Cars.

Repairs to Steel Freight Cars. J. F. MacEnulty. Read before the New England R. R. Club. Considers the repairs to steel cars and the cost, illustrating wrecked cars and the damage sustained. 1800 w. R R Gaz—Dec. 7, 1906. No. 80875.

Steel Cars from the Middletown Car Works. Illustrates and describes recent designs made by this company. 800 w. Ry Age—Dec. 28, 1906. No. 81322.

Superheaters.

Locomotive Superheaters. F. J. Cole. An illustrated review showing the progress from the earliest form of superheater, and the latest practise. General discussion follows. 11000 w. Pro Cent Ry Club—Nov. 9, 1906. No. 81059 C.

Valve Gear.

The Walschaerts Valve Gear. An account of the development of this gear for giving motion to the valve in reversing steam engines, explaining its action. 3000 w. Engr, Lond—Dec. 21, 1906. No. 81345 A.

NEW PROJECTS.

Cape-Cairo.

Cape to Cairo Railway. Sir Lewis Mitchell. An explanation of the aims and

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objects of this scheme, and interesting information in regard to the line. General discussion. Map. 8500 w. Jour Soc of Arts—Dec. 21, 1906. No. 81327 A.

New York.

The New York Connecting Railroad. Information concerning the proposed facilities for the belt line which will connect the Pennsylvania, New York & Long Island, and the New York, New Haven & Hartford railroads, with a review of the history of the struggle for a franchise from the city. Map. 2800 w. R R Gaz—Dec. 28, 1906. No. 81303.

Omaha.

The Omaha Cut-Off of the Union Pacific. Illustrated detailed description of the construction work. 1600 w. R R Gaz—Dec. 21, 1906. No. 81208.

St. Paul Pacific.

Chicago, Milwaukee & St. Paul's Pacific Coast Extension. Map showing the new route, with an outline of the construction work. 1200 w. Ry Age—Dec. 14, 1906. No. 81042.

Tehuantepec.

The Tehuantepec Railway of Mexico. Gilbert Cunningham Terry. An illustrated account of the physical features and equipment of the line and a study of its apparently very important influence in changing the future course of trans-Isthmian traffic. 4000 w. Engineering Magazine—Jan. 1, 1907. No. 81195 B.

Virginia.

The Deepwater and Tidewater Railways. Begins an illustrated detailed description of the location, standards adopted and construction methods employed for this new trunk line which will connect the W. Va. coalfields with tidewater near Norfolk, Va. 5500 w. Eng Rec—Dec. 15, 1906. Serial. 1st part. No. 80990.

PERMANENT WAY AND BUILDINGS.

Bumping Posts.

New Bumping Posts for the Lackawanna. Illustrated description of the standard concrete bumping-posts adopted by this road for use in freight yards. 600 w. Ry Age—Dec. 21, 1906. No. 81222.

Coal Pocket.

Reinforced Concrete Coal Trestle Pocket. George T. Hand. Illustrates and describes a retail coal trestle pocket, constructed entirely of reinforced concrete, recently completed at Murray Hill, N. J., on a branch of the D. L. & W. R. R. 1500 w. Ry Age—Nov. 30, 1906. No. 80791.

Cross Ties.

Cross-Ties Used by Railroads in the United States in 1905. Interesting statistics concerning the number and origin of cross-ties used by steam railroads. 500 w. Ry Age—Nov. 30, 1906. No. 80790.

Practicability and Life of Metal Cross Ties for Railroad Track Construction. H. T. Porter. Gives the writer's experience with such ties. Also discussion. Ills. 8000 w. Pro Ry Club of Pittsburgh—Sept., 1906. No. 80852 C.

Express Station.

The New Express-Freight Station of the Northern Ry. of France, at Paris (Note sur la Nouvelle Halle des Messageriês de la Compagnie du Chemin de Fer du Nord). D. Dupuis. Illustrated description of station and methods of handling express freight and postal parcels. 2 plates. 3500 w. Rev Gén des Chemins de Fer—Dec., 1906. No. 81131 G.

Lighting.

Lighting of Railway Premises: Indoor and Outdoor. Henry Fowler. Gives examples of work on English railways where gas and oil are used for lighting, with remarks on electric lighting for this purpose. Ills. 9000 w. Inst of Mech Engrs—Dec. 14, 1906. No. 81262 D.

Round-House.

Round-House with Crane Service. An illustrated detailed description of a new round-house at Pueblo, Colo., on the Denver & Rio Grande R. R. 1000 w. Ry Mas Mech—Dec., 1906. Serial. 1st part. No. 80964.

Shops.

Organization and Economy in the Railway Machine Shop. H. W. Jacobs. A summing up of the author's series on the topic; practical economies in the erecting shop, and the effect of personal stimulus on shop operatives are the special subjects covered in this concluding paper. 3500 w. Engineering Magazine—Jan., 1907. No. 81196 B.

Electrical Equipment of the Hornellsville Shops of the Erie Ry. Illustrated description. 2200 w. Ry & Engng Rev—Dec. 1, 1906. No. 80788.

El Paso & Southwestern Ry. Shops. J. L. Campbell. Illustrated description of shops built of concrete, brick, and steel. 2700 w. Ry & Engng Rev—Dec. 29, 1906. No. 81348.

Signalling.

Automatic Electric Block Signalling—Electrified Lines Long Island Railroad. Illustrated detailed description of the system of automatic block signals with alternating-current track circuits. 1000 w. Elec Ry Rev—Dec., 1906. No. 81048.

Signalling at Newcastle-on-Tyne. States the advantages of power signalling and gives a description of the installation at the place named. The system employed is the Westinghouse electro-pneumatic. 3000 w. Engr, Lond—Dec. 7, 1906. No. 81032 A.

The Adaptability of Electricity in Foggy Weather on Railways. Illustrates and describes electric fogging apparatus

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and the signalling arrangements. 2500 w. Elec Rev, Lond—Dec. 21, 1906. No. 81335 A.

Spikes.

Holding Power of Railroad Spikes. R. I. Webber. A report of a series of experiments to determine the resistance to withdrawal, and also to determine whether the preservative has any influence upon this resistance. 5000 w. Ry Age—Dec. 14, 1906. No. 81044.

Terminals.

Beginning of Erie's Terminal Improvements. Describes work started to improve the eastern terminal of the road at Jersey City, N. J., and to better the terminal facilities. Plans. 2800 w. Ry Age—Dec. 28, 1906. No. 81323.

The New Lackawanna Terminal. Illustrates and describes features of this terminal which was designed to resist fire and furnish safety to the public. 3000 w. Ins Engng—Nov., 1906. No. 80853 C.

Modernizing Engine Terminals on the B. & O. R. R. Illustrates and describes the engine house and divisional shop facilities under construction at Washington, D. C., and Baltimore, Md., and completed work at Holloway, O. 3000 w. Ry & Engng Rev—Jan. 5, 1907. No. 81467.

Yards.

New Bay Shore Yards of the Southern Pacific at San Francisco. Illustrates and describes the yard arrangements at this important terminal. 800 w. R R Gaz—Jan. 4, 1907. No. 81440.

MISCELLANY.

Supplies.

The True Perspective of the Supply Department. Ernest J. M'Veigh. A brief outline of the duties and requirements of a supply agent. 1500 w. R R Gaz—Dec. 21, 1906. No. 81209.

STREET AND ELECTRIC RAILWAYS

Acceleration.

The Starting Acceleration on Electric Raliways (Ueber die Anfahrbeschleunigung bei Elektrischen Bahnen). Dr. W. Kummer. Mathematical discussion of different kinds of acceleration and their effect on passengers. Diagrams. 2000 w. Schweiz Bauzeitung—Nov. 10, 1906. No. 81102 B.

Athens, Ga.

The Hydroelectric and Steam Equipment of the Athens (Ga.) Electric Railway Company. An illustrated account of the development. 2000 w. Elec Rev, N Y—Dec. 22, 1906. No. 81207.

Boston-Salem.

The Boston-Salem Interurban Line. Brief illustrated description of a trolley line of interest on account of the substantial roadbed, and improved rolling stock. 1100 w. Elec Ry Rev. Dec., 1906. No. 81049.

Brake.

History of the Grip Brake (Beitrag zur Geschichte der Zangenbremsen). Siegfried Abt. Illustrated description of various forms of brakes which grip the rail, for cable railways and rack railways. Serial. 2 parts. 3500 w. Schweiz Bauzeitung—Dec. 1 and 8, 1906. No. 81104 each B.

Brooklyn.

Improvement of the Brighton Beach Line of the Brooklyn Heights Railroad Company. An illustrated description of reconstruction made necessary by the need of eliminating crossings at grade. 2500 w. Elec Ry Rev—Dec., 1906. No. 81045.

Canal Haulage.

Electrical Haulage on the Canal D'Aire et de la Duele at Douai. Describes a change recently made in the haulage system on a portion of this canal. The tow-path has been laid with a light railway track and small towing locomotives are used. The method of working is described. 2500 w. Elect'n, Lond—Dec. 21, 1906. No. 81336 A.

Cars.

Tower and Construction Car of the Philadelphia Rapid Transit Company. Illustrated detailed description. 500 w. St Ry Jour—Dec. 1, 1906. No. 80774.

Fort Wayne.

Standards of Construction of the Fort Wayne & Wabash Valley Traction Company. An illustrated description of some of the features of an interurban road recently built between Fort Wayne and Bluffton, Ind., as a type of latest practice. 1800 w. St Ry Jour—Dec. 1, 1906. No. 80771.

Leyton.

Leyton District Council Tramways. Map and illustrated description of this recently completed system. 5500 w. Tram & Ry Wld—Dec. 6, 1906. No. 81237 B.

Mine Haulage.

Electric Mine Haulage at the Minister Achenbach Mine near Dortmund (Die Elektrisch Betriebene Lokomotivstreckenförderung auf der Zeche Minister Achenbach bei Dortmund). Hr. Hildebrand. Illustrated description of electric locomotives, track, circuits and plant in a coal mine. 1200 w. Glückauf—Nov. 17, 1906. No. 81109 D.

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New York.

The East Side Bronx Transportation Question in New York: I. Present Conditions. A review of the present situation is given in the present article. 4300 w. St Ry Jour—Dec. 29, 1906. Serial. 1st part. No. 81321.

Prussia.

New Prussian Regulations Governing the Construction and Operation of Electric Street Railways. A reprint of the more important of the new regulations. 3000 w. St Ry Jour—Dec. 1, 1906. No. 80775.

Rapid Transit.

Suggestions on Rapid Transit with Particular Reference to Rolling Stock. John P. Fox. An illustrated article considering the practical working of a number of car types as applied to the New York subway conditions. 5000 w. St Ry Jour—Jan. 5, 1907. Serial. 1st part. No. 81451.

Regenerative Control.

Regenerative Control. A. Raworth. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Discusses the control of shunt motors used for electric traction. Diagrams and discussion. 5000 w. Elect'n Lond—Dec. 7, 1906. No. 81011 A.

Electricity Regeneration by Tramway Motors. Edward H. Johnson. Extracts from a paper before the Manchester Assn. of Engrs. on "The Third Function of Electric Traction Motors." Considers types of motors and methods of control, etc. Ills. 2200 w. Mech Engr—Dec. 8, 1906. Serial. 1st part. No. 81023 A.

Single-Phase.

Proposed European Traction System Employing Rectified Single-Phase Currents. Illustrated description of permutator developed abroad for converting alternating currents to direct currents, and of a "regulating rectifier," resembling it, being tested in Paris. 1200 w. St Ry Jour—Dec. 1, 1906. No. 80773.

Subways.

New York's New Subways. Map and information concerning the seven new subway routes to be built by the City of New York. 1200 w. Eng News—Dec. 27, 1906. No. 81285.

Terminals.

Contracts for the Use of Terminals. Gives examples showing the varied character of the terms under which interurban lines enter cities. 2500 w. St Ry Jour—Dec. 8, 1906. Serial. 1st part. No. 80902.

Proposed Down-Town Terminal of the Hudson River Tunnel System. Illustrations showing the exterior appearance of the buildings, and indicating the inside arrangement. The two office buildings which will be built on the terminal site on Church St. from Cortlandt to Fulton St. will be 22-stories high above the surface. 900 w. Ry Age—Dec. 14, 1906. No. 81043.

Central Tramway Terminus and Sidings at Liverpool. Plan and description of track-work in Liverpool at the principal terminus. 1500 w. Elec Engr, Lond—Dec. 14, 1906. No. 81239 A.

Market Street Terminal, Philadelphia. Illustrates and describes the arrangement of the buildings and tracks, and building details. 1500 w. Elec Ry Rev—Jan. 5, 1907. No. 81469.

Tests.

How to Analyze Train Tests. Sidney W. Ashe. Gives a report prepared in connection with a series of tests made upon elevated cars, showing how speed-time curves may be analyzed. 1600 w. St Ry Jour—Dec. 1, 1906. No. 80772.

Tracks.

Tramway Track Work. R. C. Bullough. Discusses important matters concerning present-day tramway track work. Ills. 2500 w. Mech Engr—Dec. 1, 1906. No. 80918 A.

The Track Department of the Detroit United Railways. An illustrated article describing the work of this department. 2800 w. St Ry Jour—Dec. 22, 1906. No. 81206.

Specifications for Track Material Adopted by the German Street and Interurban Railway Association. Gives specifications showing the minimum qualifications that the association considers should be embodied in material. 1600 w. St Ry Jour—Jan. 5, 1907. No. 81452.

Tri-City.

Track Construction and Other Improvements of the Tri-City Railways. Illustrates and describes extensive improvements being made in the railway properties of Rock Island and Moline, Ill., and Davenport, Ia. 1500 w. St Ry Jour—Jan. 5, 1907. No. 81450.

Tube Railways.

Great Northern, Piccadilly, and Brompton Railway. Illustrated description of London's longest tube, representing the latest practice. A system of high-tension three-phase transmission to sub-stations with low-tension continuous current feeding to the working conductors. 8000 w. Tram & Ry Wld—Dec. 6, 1906. No. 81236 B.

The Great Northern, Piccadilly and Brompton Railway. Map and illustrated description of the second of the tube railways associated with the Underground Electric Railways Co. of London. 3500 w. Elect'n, Lond—Dec. 7, 1906. Serial. 1st part. No. 81010 A.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy, United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de F r. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

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Henley's Encylopedia of Practical Engineering and Allied Trades. Edited by Joseph G. Horner. Five volumes. Size 9½ by 7 in.; 500 pp. per volume. Fully illustrated. Price per volume, $6; per set, $25. New York: The Norman W. Henley Publishing Company.

Reinforced Concrete. By Albert W. Buel and Charles S. Hill. Second Edition. Size, 9 by 6 in.; pp. xii, 499. Ill. Price, $5. New York: The Engineering News Publishing Company.

Metallurgy of Cast Iron. By Thomas D. West. Eleventh Edition. Size, 7 by 4½ in.; pp. xxiii, 627. Ill. Price, $3. Cleveland, O.: The Cleveland Printing Company. New York: David Williams Co.

Boiler Waters: Scale, Corrosion, Foaming. By William Wallace Christie. Size, 9 by 6 in.; pp. vii, 235. Ill., 77. Price, $3. New York: D. Van Nostrand Co.

The Economics of Railroad Construction. By Walter Loring Webb. Size, 8 by 5 in.; pp. viii, 339. Figures, 34. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Mineral Industry. Vol. XIV. Edited by Walter Renton Ingalls. Size, 9 by 6 in.; pp. xix, 739. Price, $5. New York and London: Engineering and Mining Journal.

Switchboards. By Wm. Baxter, Jr. Size, 8 by 5½ in.; pp. 192. Ill. Price, $1.50. New York: The Derry-Collard Company.

Modern Tunnel Practice. By David McNeely Stauffer. Size, 9½ by 6 in.; pp. viii, 314. Ill., 138. Price, $5. New York: Engineering News Publishing Company.

The Management of Electrical Machinery. By Francis B. Crocker and Schuyler S. Wheeler. Sixth Edition. Size, 6½ by 4½ in.; pp. vii, 223. Ill. Price, $1. New York: D. Van Nostrand Company.

Clays, Their Occurrence, Properties and Uses. By Heinrich Ries. Size, 9 by 6 in.; pp. xvi, 490. Figures, 65; plates, 44. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Punches, Dies and Tools for Manufacturing in Presses. By Joseph V. Woodworth. Size, 9 by 6 in.; pp. 483. Figures, 700. Price, $4. New York: The Norman W. Henley Publishing Company.

The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum. Second Edition. Size, 9 by 6 in.; pp. xiv, 480. Ill. Price, $4. New. York: The Engineering News Publishing Company.

Notes on Metallurgical Mill Construction. Edited by W. R. Ingalls. Size, 9 by 6 in.; pp. vii, 256. Ill. Price, $2. New York and London: The Engineering and Mining Journal.

Locomotive Performance. By William F. M. Goss. Size, 9 by 6 in.; pp. xvi, 439. Figures, 229. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Walschaert Locomotive Valve Gear. By W. W. Wood. Size, 7 by 5 in.; pp. 193. Ill. Price, $1.50. New York: The Norman W. Henley Publishing Company.

The American Steel Worker. By E. R. Markham. Second Edition. Size, 8 by 5½ in.; pp. 366. Ill., 163. Price, $2.50. New York: The Derry-Collard Company.

Outlines of Practical Sanitation for Students, Physicians and Sanitarians. By Dr. Harvey B. Bashore. Size, 7 by 5 in.; pp. vi, 208. Figures, 42. Price, $1.25. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Mechanical Draft: A Practical Handbook for Engineers and Draftsmen. By J. H. Kinealy. Size, 6½ by 4 in.; pp. xiv, 142. Tables; Ill. Price, $2. New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

Modern Milling Machines: Their Design, Construction and Working. By Joseph G. Horner. Size, 9 by 6 in.; pp. ix, 304. Ill., 269. Price, $4. New York: The Norman W. Henley Publishing Company. London: Crosby Lockwood and Son.